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UPON POLYEMBRYONY AND ITS MORPHOLOGY IN OPUNTIA VULGARIS.

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(WITH PLATE XVI)

MANY cases of polyembryony are now known, occurring in widely separated groups. Braun, in his summary of the subject in 1860, recorded twenty-one cases in twelve families and thirteen genera, which number has been added to by others. Strasburger was the first to thoroughly investigate its morphological basis, and since his paper in 1878 important contributions have been made to the subject by several investigators, notably Dodel (1890), Overton (1891), Tretjakow (1895), Jeffrey (1895), and Hegelmaier (1897). The results of these works, in so far as they touch this subject, will be found summarized below. In the Cactaceæ, the only case of polyembryony hitherto known has been that of *Opuntia tortispina*, which Engelmann, in his Cactaceæ of Whipple's expedition figured (*pl. 23, fig. 4*) as having two embryos in one seed. This case was cited by Braun (p. 155, *pl. 5, figs. 18–20*), who also suggests that the four cotyledons which he had himself noticed in *Opuntia glaucophylla* may indicate a fusion of two embryos and hence polyembryony, though he points out that it may also be explained as fasciation. While studying the seedling stages in this family, I have found that *Opuntia vulgaris* is markedly polyembryonic, and I may here add that although I have worked

over the seedlings of some seventy-five species in this family I have seen no other case of it.

The plants from which my seeds were taken have been growing and flowering luxuriantly for at least four years in the Botanic Garden of Smith College. They agree with the characters given in books for that species, but the source from which they came into the garden is unknown. They set seed every year in great abundance. When the seeds are planted, from many, perhaps a half, of them more than one seedling comes up, and there is the greatest variation in the number, size, and degrees of union with one another of these seedlings. This variety is best made evident by the *figs. 1* to *5*, typical cases drawn the natural size, and of course there are all stages between. I have not tried to follow them further, but what I have noticed seems to show that the larger of a set crowds out the others. It is now important to ascertain the morphological origin of this polyembryony.

The ovule of *Opuntia vulgaris* is at first amphitropous, but in its development it becomes elongated and bent, at the same time turning around in such a way that the funiculus makes a complete turn around it, so that finally it simulates a campylotropous condition (*fig. 6*). Its development in other species of this genus, together with the development of other species of other genera in this family, has been described by d'Hubert, and his account fits this species fairly well. Inside of the funiculus are the integuments, made up of three distinct layers of cells, and inside of these is a nucellus, which becomes absorbed, except for a small portion (at *x*, *fig. 6*), by the embryo as the seed ripens. Finally there is the distinct embryo sac, in which there forms after fertilization an abundant endosperm, which consists of protoplasts without cellulose walls, the whole of course absorbed by the growing embryo.

In ripe seeds one finds usually a large embryo nearly filling it, with others much smaller and pressed to one side. In half-ripe seeds one finds such a condition as is shown in *fig. 8*, where there is one larger embryo with several smaller ones, and usually

the larger comes not from the micropylar extremity of the embryo sac, but from some point on its wall a little removed. In other cases one sees a single embryo springing from the micropylar end and one or more from the walls, as in *fig. 7*. Or again, though rarely, there is a single embryo at the micropylar end, as in *fig. 9*. There is a close resemblance between these figures and those given by Strasburger for *Citrus Aurantium* (*fig. 37*). If now these be examined in a still younger stage, it becomes clear that the embryos come from two different positions: first, from a rather irregular mass of tissue which lies at the micropylar end of the embryo sac, and extends thence along its wall; and second, directly from the wall itself. Both of these conditions are well shown in *fig. 10*. It is important to notice, however, that some cases seeming to belong to the latter category belong really to the former, as is illustrated by *fig. 15*, where the wall-standing embryos are shown to spring really from the mass at the micropylar end, but this is not the case with all of the wall-standing embryos, for sections show that in many cases, *i. e.*, *fig. 10*, these are entirely independent of that mass. It is probable that the irregular embryos come as a rule from the micropylar mass, while the regular ones are from the walls, for all I have seen in that position have regularly two cotyledons.

So far, in tracing backwards the origin of the polyembryony, everything is plain, and it is easy to find plenty of cases such as are here figured. At this stage, the entire distinctness of the micropylar mass from the nucellus beneath (see *figs. 10* and *11*) and its close resemblance to that described and figured by Jeffrey which he traced to its origin in a fertilized egg cell, would lead one to suppose that we have here a similar case; while in the wall-standing embryos, which are so sharply distinct from the nucellus (*fig. 11*) that an origin from nucellus seems excluded, only an origin from an endosperm cell would appear possible, a condition which is yet unknown.[1] But the earlier stages show that both of these suppositions are incorrect. In a great

[1] This was my own opinion in both cases at the time this paper was read before the

abundance of material which shows the ovules in all stages before and at the time of fertilization, and also all stages after that represented in *fig. 10*, I was able to find, after prolonged and careful search, only three cases which show the origin of the embryos, but happily they leave no doubt on the subject. I think this stage must be passed through very rapidly, and perhaps at night, when none of my material was collected.

In stages earlier than *fig. 10*, the pollen tube can usually be seen in the micropylar region of the nucellus, but an egg cell cannot be detected. Instead there regularly lies in its position a crumpled mass of protoplasm (*fig. 12, 14, pr.*), shrunken in my material by the weak alcohol used to preserve it. I think the egg cell disappears early in the development of the ovule, a point which will be cleared up by a complete study of the development of the embryo sac, now being made by one of my students. At all events there is certainly no egg cell present in any of my preparations at the period when the embryo building begins. The nucellus cells near the pollen tube are rich in contents, and in one case (*fig. 12*) I have found these beginning to bud out into the embryo sac. That these represent the beginning of the formation of the micropylar mass, I think there can be no question. It is precisely in this way that the adventitious embryos originate in Funkia and other cases, as described so fully and clearly by Strasburger. In another case (*fig. 13*) there are present not only the richly protoplasmic nucellus cells near the pollen tube, here, however, not budding, but also other nucellus cells a little removed and separated by a space filled with cells rather poor in contents; and these cells with rich contents are also distinctly budding out (*fig. 13, x*). Now these, I believe there can be no doubt, are the beginning of the wall-standing embryos; it is quite probable that at first they are continuous with those near the pollen tube, but are removed from them by the growth in length of the embryo sac, which at this time is very rapid. At all events they are nucellus cells. The

Society for Plant Morphology and Physiology, Dec. 29, 1897. I had not then found the three cases next to be described, which prove the origin to be different.

third case I have found is represented in *fig. 14*, which is more advanced than *fig. 13*, and where the differentiation of the richly protoplasmic cells of the embryonic mass from the nearly empty cells beneath it is fairly sharp, but nevertheless the relations of the two kinds are still sufficiently close to show the origin of the one from the other. Another section of the same specimen shows a similar connection of the other mass of embryonic tissue with the nucellus.

From these cases it is clear that in this species the embryos of both positions arise from the nucellus, and in this respect agree with Funkia, Nothoscordum, Citrus, and others, the usual method.

A synopsis of the modes of origin of polyembryony is given by Tretjakow, which in synopsis, with the additions made by others, and excluding cases due to branching of the nucellus, union of two ovules, presence of two or more embryo sacs in one nucellus, etc., are as follows: From cells of nucellus near the micropyle, *Funkia* and others (Strasburger); from a second egg cell, *Santalum*, or from its doubling *Sinningia* (Strasburger); from synergids, *Mimosa Denhartii* (Guignard), *Iris Sibirica* (Dodel), and perhaps in *Lilium Martagon* (Overton); from the antipodals and synergids, *Allium odorum* (Tretjakow); from the branching of a mass of tissue derived from the fertilized egg cell (Jeffrey); finally, Hegelmaier points out the occurrence in *Allium odorum* of embryos from egg cell, synergids, antipodals and nucellus cells, all in the same species and individuals. There still remain as possible origins, endosperm and integument. In all known cases, except *Cœlebogyne*, the production of the new embryos takes place only after fertilization, or at all events after the entrance of the pollen tube.

A question of great interest now arises as to the significance of polyembryony. Strasburger, though he mentions that it recalls apogamy, then recently discovered by Farlow, contents himself with referring to the extra embryos as "Adventivknospen" or "vegetative Adventivkeime." Pfeffer[2] has suggested that it is but a case of budding, and that the specific conditions

[2] Pflanzenphysiologie 1: 29. 1897.

in the embryo sac determining the form of the sexually produced embryo, give the same form to the adventitious embryos. Tretjakow suggests that the development from the antipodals represents apogamy, the antipodals being homologous with the vegetative cells of the prothallus, but this explanation will not apply to the origin from nucellus cells. Jeffrey has nothing to say on this point, while Hegelmaier concludes his paper thus:

> Die verhältnissmässige Seltenheit der dem Eiapparat entspringenden Polyembryonie bei *A. odorum* einerseits und das öftere gelegentliche Vorkommen dieser Form bei verschiedenen anderen Pflanzen andererseits könnte vielleicht zu der Auffassung führen, dass ihr Vorkommen bei unserer Pflanze überhaupt nicht in dieselbe Reihe mit dem Vorkommen der anderen Formen von Polyembryonie bei ihr zu stellen und ihr Zussammentreffen mit diesen anderen Formen mehr nur ein zufälliges sei. Aber mindestens für diese letzteren ist doch wohl die Annahme unabweisbar, das irgendwelche gemeinschaftlichen Ursachen vorhanden sein müssen, für deren Erkenntniss durch ein Spiel mit morphologischen Homologien nichts zu gewinnen sein würde.

In general for a new feature one of three origins may be supposed. First, it may be some incidental growth or functional condition. Here comes the explanation of budding, and Pfeffer's explanation of the assumption of the embryo form through specific qualities of the embryo sac. But polyembryony seems too distinct and elaborate a process to be thus explained. Second, it may be a relic of some older condition now disappearing. But its very different morphological origins are against this. Here comes its explanation as apogamy, but this does not explain the origin from the nucellus. Third, it may be the early stages in the development of something new. It can hardly yet be of any service to the plants, for many of the embryos are absorbed before the seeds are ripe, and in other cases usually but one develops, though perhaps one of the smaller may sometimes take the place of the leader if this is destroyed. Its origin in several distinct groups and by several distinct methods seems to imply that there is some virtue in the development of the extra embryos, and that their appearance is controlled by that influence, whatever it may be, which is much more powerful than mere morphological inertia, and which elsewhere forms new

structures from the most different morphological origins. In its independent appearance in distinct groups it is comparable with the appearance of heterospory, but whether polyembryony like heterospory will lead to some higher condition remains to be seen, though we shall not see it.

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BIBLIOGRAPHY.

BRAUN, A.— Ueber Polyembryonie und Keimung von Cœlebogyne. 1860.

HEGELMAIER, F.— Zur Kenntniss der Polyembryonie von *Allium odorum* L. Bot. Zeit. **55**: 133. 1897.

HUBERT, E. D'.— Recherches sur le sac embryonnaire des plantes grasses. Ann. Sci. Nat. VIII. **2**: 37. 1896.

JEFFREY, E. C.— Polyembryony in Erythronium americanum. Ann. Bot. **9**: 537. 1895.

STRASBURGER, E.— Ueber Polyembryonie. Zeitschr. f. Naturw. **12**: 647. 1878.

TRETJAKOW, S.— Die Betheiligung der Antipoden in Fällen der Polyembryonie bei *Allium odorum* L. Ber. d. deutsch. Bot. Gesells. **13**: 13. 1895.

A fuller bibliography and references may be found in Tretjakow.

EXPLANATION OF PLATE XVI.

Figures all drawn with camera lucida, and the original drawings reduced one-half.

In all of the figures, *e. s.* = embryo sac; *n.* = nucellus; *in.* = the integuments collectively; *i. i.* = inner integument; *m.* = micropyle or micropylar opening through the nucellus; *p.* = pollen tube; *pr.* protoplasm of embryo sac.

FIGS. 1, 2, 3, 4, 5, each showing the embryos from a single seed, natural size.

FIG. 6. Median section through an ovule of *Opuntia vulgaris*, somewhat diagrammatized, six times natural size: *f* = funiculus; *a* = attachment of funiculus to ovule; *x* = portion of nucellus not absorbed when seed is ripe.

FIG. 7. Embryo sac showing three embryos, one from the micropylar end and two from the wall. × 18.

FIG. 8. Embryo sac showing one large embryo on the wall and several smaller from the micropylar end. × 18. Not a section, but a half seed laid open.

FIG. 9. Embryo sac showing a single embryo from the micropylar end. × 35.

FIG. 10. Embryo sac showing embryos on the wall together with the branching mass from the micropylar end. Nucellar cells drawn nearly exactly; those of embryos exact on the outside but only approximate in the interior. × 90.

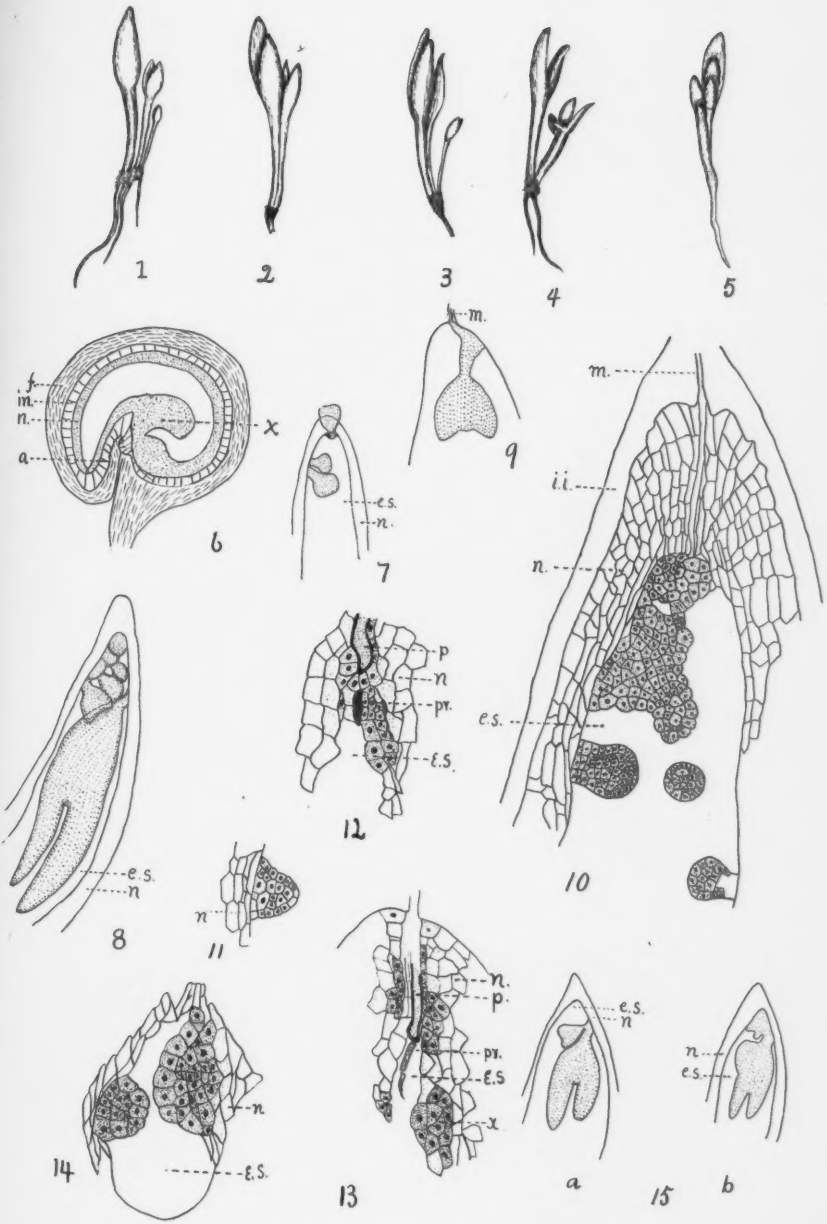
FIG. 11. An embryo on the wall; to show the connection of cells of embryo to those of nucellus; a microtome section. × 90.

FIG. 12. Beginning of budding from nucellus cells near the micropyle. × 90.

FIG. 13. Cells of nucellus beginning to grow out at *x* into an embryo. × 90.

FIG. 14. Embryonic mass separating from the nucellus. The section is cut diagonally through the apex of the embryo sac. × 90.

FIG. 15. *a*, *b*. Two sections from one embryo sac to show that some apparently wall-embryos are really from the micropylar mass. × 18.



GANONG on POLYEMBRYONY.

FLOWERS AND INSECTS. XVIII.

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ACTÆA L.— *A. spicata* L. is a white pollen-flower with incomplete proterogyny, though Axell regarded it as homogamous. Dr. Buddeberg's observation at Nassau of the visits of *Byturus fumatus* F. (Dermestidæ) and *Forficula auricularia* L. (Orthoptera) hardly indicates more than partial investigation or unfavorable conditions (4).

ACTÆA ALBA Bigel.— This agrees with observations made on *A. spicata*, of which it has been regarded as a mere variety.

The plant is rather rare, in low rich woods, rising 4–5^{dm} and bearing short racemes. The sepals fall when the flower opens. The numerous stamens and the stigma are white and are the most conspicuous parts, the slender petals being of little use. The ovary is surmounted by large two-lobed stigma, which is receptive before the anthers open. The stamens are turned to a more or less horizontal position, so that, after the anthers open, the insect visitors are likely to touch the stigma before being dusted with pollen. The flowers open almost simultaneously. The proterogyny is incomplete, nectar is wanting, and the insects abandon the flowers as soon as the pollen is gone.

From their white color, small size and nectarless condition, the flowers seem to depend upon the females of small species of Halictus, by which they are abundantly visited. The blooming season is from May 3 to 23, a plant found in bloom on June 20 seeming quite an exceptional case. On May 8 the following visitors were observed :

Bees — *Andrenidae* : (1) Andrena sp. ♀, c. p. ? ; (2) Halictus pectoralis Sm. ♀, c. p., ab.; (3) H. zephyrus Sm. ♀, c. p.; (4) Augochlora confusa Rob. ♀, f. p.

On the pollination of Actæa see :

(1) Axell, Om anordningarna för de fanerogama växternas befruktning 60, 104. 1869.—(2) Ricca, Osservazioni sulla fecondazione incrociata dei vegetali alpini e subalpini. Atti Soc. Ital. Sci. 13:254. 1871; 14:249. 1872. *A. spicata*, distinctly proterogynous. cit. by Delpino.— (3) Delpino, Ulteriori osservazioni II. 2:178. Atti Soc. Ital. Sci. 16:326. 1873. *A. spicata*, probably macrobiostigmatic.—(4) Müller, Weitere Beobachtungen 1:53. 1878.—(5) Kirchner, Beiträge zur Biologie der Blüten. Progr. 72 Jahresfeier Kgl. Württemb. landwirtschaftl. Akad. Hohenheim 18. 1890. *A. spicata*. (Just 18^1:492).—(6) Kerner, Pflanzenleben 2:—. 1891. Oliver translation 2:183, 310. 1895. *A. spicata*, attractive stamens, etc.

LESPEDEZA PROCUMBENS Michx.—The flowers are bright purple, especially the vexillum. There is a white triangular mark at base of the latter forming a pathfinder. The stamens and pistil are protected by the keel, which at first returns to its position when depressed. The stigma strikes the visitor in advance of the anthers. The calyx and claw of the banner are short, so that a tongue 2–3 mm long can exhaust the nectar.

The blooming season is Aug. 2–Sept. 21. On Aug. 14 and 15 the following visitors were observed:

Bees — *Apidae:* (1) Megachile brevis Say ♀, s. & c. p.; (2) Ammobates illinoensis Rob. ♂♀, s.; (3) Calliopsis andreniformis Sm. ♂♀, s.; *Andrenidae:* (4) Halictus confusus Sm. ♀, s. & c. p.; (5) Augochlora confusa Rob. ♀, s. & c. p.

Diptera — *Bombylidae:* (6) Systoechus vulgaris Lw., s.

Lepidoptera — *Rhopalocera:* (7) Lycaena comyntas Gdt., s.

LESPEDEZA RETICULATA Pers.— *L. Virginica* (L.) Britt.—The plants grow 3–4 dm high, are very leafy and rather densely covered with rose-colored flowers. The flower is about 5 mm long, the calyx tube about 2 mm, and the claw of the banner about 1.5 mm.

The blooming season is July 30–Sept. 14. On Aug. 22, 27, 29, 31, and Sept. 2, 4, 7 the following visitors were observed:

Bees — *Apidae:* (1) Bombus americanorum F. ♂♀, s. & c. p., freq.; (2) Anthophora walshii Cr. ♀, s.; (3) Melissodes nivea Rob. ♀, s. & c. p.; (4) Megachile optiva Cr. ♀, s. & c. p.; (5) M. brevis Say ♂♀, s. & c. p., ab.; (6) M. latimanus Say ♀, s.; (7) Coelioxys totonaca Cr. ♀, s.; (8) Epeolus concavus Cr. ♀, s.; (9) E. lunatus Say ♀, s.; (10) Calliopsis andreniformis Sm. ♂♀, s.; (11) Panurginus compositarum Rob. ♂, s.; *Andrenidae:* (12)

Halictus ligatus Say ♂, s.; (13) Augochlora confusa Rob. ♂, s.; (14) A. similis Rob. ♂, s.; (15) Colletes americanus Cr. ♂, s.

Lepidoptera — *Rhopalocera:* (16) Lycaena comyntas Gdt., freq.; (17) Thecla melinus Hbn.; (18) Colias philodice Gdt.; (19) Pamphila cernes Edw.— all s.

LESPEDEZA CAPITATA Michx.— The flowers are white, pink streaks on the base of the banner forming pathfinders. The wings and keel are depressed together and return to their position covering the stamens and pistil. The claw of the banner is so long that a proboscis 3–4 mm long is needed to reach the nectar. Its infolded edges guide the bee's tongue to the opening in the stamen tube.

The blooming season is Aug. 14–Sept. 11. On Aug. 14 and 23 I saw the flowers visited by two bees: *Megachile brevis* Say ♀, s. & c. p., and *Calliopsis andreniformis* Sm. ♂, s.

On the pollination of Lespedeza see:

(1) Berkeley, Sterility — constitutional and organic. Gardener's Chronicle 1: 36. 1855. Cleistogamy, both kinds of flowers simultaneous. Cit. by Henslow.— (2) Kuhn, Einige Beobachtungen über Vandellia und den Blüthenpolymorphismus. Bot. Zeit. **25**: 67. 1867.— (3) Axell, Om anordningarna för de fanerogama växternas befruktning 11. 1869. Cites Kuhn.— (4) Henslow, On the self-fertilization of plants. Trans. Linn. Soc. II. Bot. 1: 327. (1877) 1880.— (5) Foerste, Notes on structures adapted to cross-fertilization. Bot. Gaz. **13**: 152. 1888. *L. violacea* (Just **16**[1]: 533).

CORNUS L.— The flowers are perfect. According to Gray's Manual some foreign species are dioecious. In the Tyrol Schulz (12) failed to verify the observation of Hausmann that *C. Mas* is dioecious or polygamous. From the condition of certain examples of *C. Canadensis* after flowering Meehan (14) inferred that this species is monoecious and dioecious.

The flowers have four petals, four stamens, a single style with terminal or capitate stigma, the base of the style being surrounded by an epigynous nectar disk.

One group of Cornus consists of species whose flower clusters are surrounded by an involucre, which is usually white. In these the petals are less conspicuous, and, at least in some cases, less expanded, so that they limit access to the nectar.

In the other group the conspicuousness of the inflorescence depends upon the individual flowers, whose petals are white and widely expanded. The nectar is therefore freely exposed.

The flowers are homogamous. In *C. sanguinea* Müller (4, 8) observed that insects may effect cross or self-pollination, and in their absence that spontaneous self-pollination or geitonogamy may occur.

Sprengel (1) observed that *C. sanguinea* was visited by a variety of insects. Müller's list shows fourteen beetles, five flies and one Pompilus. Delpino (3) includes this species in his "Tipo idrangeino," which he regards as adapted to beetles.

CORNUS FLORIDA L.—Kerner (13) supposes that the bracts serve as attractive organs and as landing places for insects. But insects visiting the flowers seldom alight on them. He also mentions what he calls "arrangements for geitonogamy," which seem to me to be quite imaginary.

This small tree occurs in only one place in my neighborhood. A dozen or more flowers are collected in a head. The four scales of the hibernaculum, which encloses the developing head, greatly elongate and expand at base, at the same time assuming a white or pinkish color. Very frequently the two inner scales remain united, so that by their basal expansion they form an arch over the head. These parts are often folded inwards in the middle, with the result that the head is often more conspicuous laterally than would be the case if all of the scales were expanded horizontally.

Nectar is secreted by an epigynous disk. The calyx tube is about 1^{mm} deep. This with the four petals and four filaments has the effect of concealing the nectar in a tube about 2^{mm} deep.

The petals are greenish yellow, their tips being reflexed, the flower expanding about 4^{mm}. The stamens are strongly divergent and are exserted about 4^{mm}, the style projecting little more than 1^{mm}.

The flowers are homogamous. Insects crawling about over the inflorescence get their heads and undersides covered with pollen. On sucking they easily effect pollination. In their

absence spontaneous self-pollination or geitonogamy may sometimes occur by the pollen falling upon the stigmas. In Cornus and Viburnum the elongation and strong divergence of the stamens is no kind of an "arrangement for geitonogamy," though it may result in that, but merely places the anthers in position to strike insects which run about irregularly over the flowers.

The flowers were noted in bloom from April 22 to May 8. In this time very few of the lower aculeate Hymenoptera are flying. The following list, observed on April 23, showing a strong preponderance of Andrenidae, with flies less abundant, is about what might be expected from the structure of the flowers and the composition of the insect-fauna at the blooming time:

Hymenoptera — *Apidae:* (1) Bombus separatus Cr. ♀, s., one; (2) Osmia albiventris Cr. ♀, s. & c. p., one; (3) Nomada sayi Rob. ♂, s.; *Andrenidae*: (4) Halictus foxii Rob. ♀, s. & c. p.; (5) H. coriaceus Sm. ♀, s.; (6) H. fasciatus Nyl. ♀, s. & c. p., freq.; (7) H. pilosus Sm. ♀, s. & c. p.; (8) H. zephyrus Sm. ♀, s.; (9) H. confusus Sm. ♀, s.; (10) H. obscurus Rob. ♀, s. & c. p.; (11) H. stultus Cr. ♀, s. & c. p., freq.; (12) Agapostemon radiatus Say ♀, s.; (13) Augochlora pura Say ♀, s. & c. p.; (14) A. confusa Rob. ♀, s. & c. p.; (15) Andrena vicina Sm. ♀, s.; (16) A. bipunctata Cr. ♂ ♀, s. & c. p., freq.; (17) A. rugosa Rob. ♂ ♀, s.; (18) A. claytoniae Rob. ♀, s. & c. p., freq.; *Vespidae*: (19) Polistes metricus Say, s.; *Eumenidae*: (20) Odynerus foraminatus Sauss., s., one.

Diptera — *Empididae:* (21) Empis humilis Coq., freq.; *Bombylidae:* (22) Bombylius pulchellus Lw.; (23) B. major L.; *Syrphidae:* (24) Chilosia capillata Lw.; (25) Mesograpta marginata Say; (26) Criorhina umbratilis Will.; *Lonchaeidae:* (27) Lonchaea polita Say — all s.

Lepidoptera — *Rhopalocera:* (28) Nisoniades juvenalis F., s.

Coleoptera — *Cerambycidae:* (29) Molorchus bimaculatus Say, s. & f. p.

CORNUS PANICULATA L'Her. — *C. candidissima* Marsh. — In his classification of floral types Delpino (3) places this species in his "Tipo idrangeino," which, as stated above, he regards as adapted to beetles. He considers the scent of the flowers, which he calls "odore carabico o scarabeo," as further indicating an adaptation to these insects. He saw the flowers abundantly visited by *Cetonia aurata* and other Coleoptera.

The shrubs are much branched, rise from 1 to 3^{m} high and

bear numerous flat or convex cymes of white flowers. The cymes expand from 4 to 5^{cm}.

The four petals are horizontally expanded to the extent of about 1^{cm}. The stigma rises to about the level of the anthers. Nectar is secreted by a yellow epigynous disk and is completely exposed.

The flowers are homogamous. Spontaneous self-pollination is usually prevented by the stamens being strongly divergent. Insects crawl about over the clusters and become thoroughly dusted with pollen. Pollination occurs between separate flowers of the same or distinct plants.

C. paniculata having completely exposed nectar is adapted to a more miscellaneous set of insects than *C. florida*, which has nectar more concealed. Nevertheless, the list of visitors of the former differs from that of the latter mainly in showing more insects of the same kind, it being a larger list. The list of *C. paniculata* shows twenty-one species of lower Aculeata and Tachinidae, only three of which are flying when *C. florida* is in bloom.

The blooming season is May 12–June 13. The following list was observed on May 12, 18, 23, 29, and June 8:

Hymenoptera—*Apidae:* (1) Apis mellifica L. ☿, s. & c. p., freq.; (2) Bombus americanorum F. ♀, c. p.; (3) Synhalonia frater Cr. ♀, c. p.; (4) Ceratina dupla Say ♀, s. & c. p.; *Andrenidae:* (5) Halictus pectoralis Sm. ♀, s. & c. p.; (6) H. pilosus Sm. ♀, s.; (7) H. confusus Sm. ♀, s. & c. p., freq.; (8) H. tegularis Rob. ♀, s., freq.; (9) H. stultus Cr. ♀, s. & c. p.; (10) Agapostemon radiatus Say ♀, s. & c. p.; (11) A. viridulus F. ♀, s. & c. p.; (12) Augochlora confusa Rob. ♀, s. & c. p.; (13) A. similis Rob. ♀, s.; (14) Andrena vicina Sm. ♀, s.; (15) A sayi Rob. ♀, s. & c. p.; (16) A. pruni Rob. ♀, s.; (17) A. platyparia Rob. ♂ ♀, s. & c. p., ab.; (18) A. cressonii Rob. ♀, s. & c. p.; (19) A. rugosa Rob. ♀, s. & c. p.; (20) A. forbesii Rob. ♀, s.; (21) A. hippotes Rob. ♀, s.; (22) A. claytoniae Rob. ♀, s. & c. p., freq.; (23) Prosopis pygmaea Cr. ♂, s.; (24) P. modesta Say ♂ ♀, s.; (25) P. affinis Sm. ♂, s.; *Eumenidae:* (26) Eumenes fraternus Say; (27) Monobia 4-dens L.; (28) Odynerus sp.; (29) O. campestris Sauss.; (30) O. unifasciatus Sauss.; (31) O. foraminatus Sauss.; *Crabronidae:* (32) Crabro interruptus Lep., freq.; (33) C. errans Fox; (34) Oxybelus emarginatus Say; *Sphecidae:* (35) Pelopoeus cementarius Dru.; (36) Chalybion caeruleum L.; *Pompilidae:* (37) Ceropales fulvipes Cr.; *Chalcididae:* (38) Smicra torvina Cr.— all s.

Diptera — *Empididae:* (39) Empis levicula Coq.; (40) E. clausa Coq.; (41) E. distans Lw.; *Conopidae:* (42) Oncomyia loraria Lw.; *Syrphidae:* (43) Pipiza pulchella Will.; (44) Chrysogaster nitida F., freq.; (45) Syrphus americanus Wd.; (46) Eristalis aeneus F.; (47) E. transversus Wd.; (48) E. dimidiatus Wd.; (49) Mallota cimbiciformis Fll.; *Tachinidae:* (50) Alophora purpurascens Twns.; (51) Jurinia apicifera Wlk., freq.; (52) J. smaragdina Mcq.; (53) Belvosia bifasciata F.; (54) Phorocera edwardsii Will., freq.; (55) Acroglossa hesperidarum Will.; (56) Frontina flavicauda Riley; (57) Atrophopoda singularis Twns.; (58) Chaetophleps setosa Coq.; *Sarcophagidae:* (59) Sarcophaga sp.; (60) Helicobia helicis Twns.; *Muscidae:* (61) Lucilia sp.; (62) L. sericata Mg.; (63) Graphomyia americana R. D.; (64) Morellia micans Mcq,; *Anthomyidae:* (65) Anthomyia marginata Wlk.; (66) Phorbia acra Wlk.; *Ortalidae:* (67) Camptoneura picta F.— all s.

Coleoptera — *Lampyridae:* (68) Podabrus tomentosus Say, freq.; (69) Telephorus flavipes Lec., freq.; *Scarabaeidae:* (70) Euphoria fulgida F.; (71) Trichius piger F., freq.; (72) T. affinis Gory, in cop.; *Cerambycidae:* (73) Strangalia famelica Newm.; *Mordellidae:* (74) Pentaria trifasciata Melsh.; (75) Mordella marginata Melsh. — all s. or f. p.

Lepidoptera — *Rhopalocera:* (76) Pyrameis atalanta L.; (77) Papilio ajax L.— both s.

On the pollination of *Cornus* see:

(1) Sprengel, Das entdeckte Geheimniss 31, 33, 85. 1793. *C. mascula, sanguinea, florida.* — (2) Axell, Om anordningarna för de fanerogama växternas befruktning 103. 1869. *C. Suecica.*— (3) Delpino, Ulteriori osservazioni II. **2**: 13, 39, 46, 52, 215, 237–8, 311. Atti Soc. Ital. Sci. **16**: 161, 187, 194, 200. 1873; **17**: —. 1874. *C. florida, Suecica, paniculata, sanguinea.*— (4) Müller, Befruchtung der Blumen 96. 1873. Fertilization of flowers 287. 1883. *C. sanguinea.*— (5) Lubbock, British wild flowers in relation to insects 107. 1875. *C. Suecica, sanguinea.*— (6) Bonnier, Les nectaires. Ann. Sci. Nat. Bot. VI. **8**: 37, 40, 71, 135. 1878. *C. Mas, sanguinea.* (Just 7^1: 120).— (7) Errera et Gevaert, Sur la structure et les modes de fécondation des fleurs. Bull. Soc. Bot. Belgique **17**: 79. 1878. *C. sanguinea.*— (8) Müller, Weitere Beobachtungen **1**: 31. 1878. *C. sanguinea.*— (9) Patton, Observations on the genus Macropis. Am. Journ. Sci. & Arts III. **18**: 211–14. 1879. *C. paniculata.* (Just 7^1: 145).—(10) Jordan, Stellung der Honigbehälter und der Befruchtungswerhzeuge in den Blumen 18. 1886. *C. sanguinea.*— (11) Kirchner, Flora von Stuttgart und Umgabung 399. 1888. *C. sanguinea.*— (12) Schulz, Bestäubungseinreichtungen und Geschlechtsvertheilung bei den Pflanzen **2**: 191. 1890. *C. Mas.*— (13) Kerner, Pflanzenleben **2**: —. 1891; Oliver translation **2**: 173, 183–4, 200, 231, 296, 289, 326. 1895. *C. florida, Mas, sanguinea, Suecica.*— (14) Meehan, Contributions to the life-histories of plants VIII. Proc. Acad. Sci. Phil. 1892: 376. *C. Canadensis, florida.* (Bot.

Centralb. **61**: 263).—(15) MacLeod, Bevruchting der bloemen van Vlaanderen. Bot. Jaarboek **6**: 256, 437. 1894. *C. sanguinea, Mas.*—(16) Loew, Blütenbiologische Floristik 248. 1894. *C. sanguinea, Mas.*

VIBURNUM PUBESCENS Pursh.—The mode of pollination of this species, along with a general account of the genus and an index to the literature, has been given in Trans. Acad. Sci. St. Louis **7**: 170–2. The list of visitors recorded there, indicating a preponderance of beetles, is fragmentary and quite misleading. Beetles are more abundant on the old flowers, of which they eat all parts. The most frequent and efficient pollinators are the less specialized bees, and flies. The blooming season is May 2–25. The following list, observed on May 4, 5, 7 and 9, includes visitors previously mentioned. It shows an interesting assemblage of Empididae, a family of flies which reaches its maximum in May.

Bees—*Apidae:* (1) Bombus americanorum F. ♀, s.; (2) B. separatus Cr. ♀, s.; (3) Synhalonia frater Cr. ♂, s.; (4) Ceratina dupla Say ♀, s. & c. p.; (5) Osmia albiventris Cr. ♀, s.; *Andrenidae:* (6) Halictus pectoralis Sm. ♀, s. & c. p., freq.; (7) H. foxii Rob. ♀, s. & c. p.; (8) H. 4-maculatus Rob. ♀, s.; (9) H. coriaceus Sm. ♀, s.; (10) H. cressonii Rob. ♀, s. & c. p.; (11) H. confusus Sm. ♀, s. & c. p.; (12) Augochlora confusa Rob. ♀, s. & c. p.; (13) Andrena vicina Sm. ♀, s. & c. p.; (14) A. sayi Rob. ♀, s. & c. p., freq.; (15) A. robertsonii D. T. ♀, s. & c. p., freq.; (16) A. mandibularis Rob. ♀, s. & c. p., freq.; (17) A. illinoensis Rob. ♀, s.; (18) A. cressonii Rob. ♂♀, s. & c. p., ab.; (19) A. personata Rob. ♂, s. freq.; (20) A. nuda Rob. ♀, s. & c. p.; (21) A. rugosa Rob. ♀, s. & c. p., freq.; (22) A. forbesii Rob. ♀, s. & c. p.; (23) A. claytoniae Rob. ♀, s. & c. p., ab.; (24) Prosopis affinis Sm. ♂, s.; (25) P. modesta Say, ♀, s.; (26) P. pygmaea Cr. ♀, s.

Diptera—*Conopidae:* (27) Myopa vesiculosa Say; *Empididae:* (28) Empis compta Coq.; (29) E. distans Lw., freq; (30) E. humilis Coq., freq.; (31) E. avida Coq.; (32) E. nuda Lw.; (33) E. levicula Coq.; (34) E. otiosa Coq.; (35) Pachymeria pudica Lw.. freq.; (36) Rhamphomyia priapulus Lw., freq.; (37) R. exigua Lw.; (38) R. sordida Lw.; (39) R. angustipennis Lw.; (40) R. mutabilis Lw.; *Syrphidae:* (41) Chilosia capillata Lw.; (42) Mesograpta geminata Say; (43) Volucella vesiculosa F.; (44) Criorhina umbratilis Will., freq.; (45) C. decora Mcq.; (46) Xylota chalybea Wd.; (47) Syritta pipiens L.; *Tachinidae:* (48) Siphona illinoensis Twns., freq.; (49) Siphophyta floridensis Twns.; *Muscidae:* (50, 51) Lucilia spp.; *Oscinidae:* (52) Chloropa proxima Say; (53) Hippelates plebejus Lw.—all s.

Coleoptera—*Dermestidae:* (54) Anthrenus musaeorum L., freq.; (55)

Cryptorhopalum triste Lec.; (56) Orphilus glabratus F., ab.; *Lampyridae:* (57) Telephorus dentiger Lec.; *Scarabaeidae:* (58) Hoplia trifasciata Say, freq.; (59) Euphoria fulgida F.; (60) Valgus canaliculatus F., gn.; *Cerambycidae:* (61) Molorchus bimaculatus Say, s., ab.; (62) Callimoxys sanguinicollis Oliv.; (63) Euderces picipes F.; *Chrysomelidae:* (64) Diabrotica vittata F., s.; (65) Disonycha limbicollis Lec., s.; (66) Pachybrachys sp., s.; *Bruchidae:* (67) Bruchus hibisci Oliv., s.; *Oedemeridae:* (68) Asclera ruficollis Say, s.; *Mordellidae:* (69) Mordellistena biplagiata Hel., freq.; (70) M. aspersa Mels., freq.: (71) M. grammica Lec.—all s., f. p., or gn.

Lepidoptera — *Rhopalocera:* (72) Papilio ajax L.; (73) Nisoniades juvenalis F.—both s.

VIBURNUM PRUNIFOLIUM L.—This is a small tree bearing numerous flat compound cymes of white flowers. The corolla expands 8–9^{mm}, its base forming a short tube, which is somewhat obstructed by the short, thick style. The five stamens are strongly exserted, while the stigma is included in the tube. Nectar is secreted by a ring surrounding the base of the style. The flowers are homogamous. Cross-pollination by insects is assured, but self-pollination and geitonogamy may sometimes occur by the pollen falling upon the stigmas.

The blooming season is April 23–May 16. The following list was observed on April 24, 25, and 29:

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s. & c. p.; (2) Synhalonia frater Cr. ♂ ♀, s.; (3) Ceratina dupla Say, ♂, s.; (4) Osmia lignaria Say ♀, s.; (5) O. albiventris Cr. ♀, s.; (6) Nomada sayi Rob. ♂ ♀, s., freq.; N. cressonii Rob. ♂, s. freq.; (8) N. maculata Cr. ♂, s.; (9) N. obliterata Cr. ♂, s.; *Andrenidae:* (10) Halictus foxii Rob. ♀, s. & c. p.; (11) H. pectoralis Sm. ♀, s. & c. p. ab.; (12) H. lerouxii Lep. ♀ s. & c. p.; (13) H. cressonii Rob. ♀, s.; (14) H. pilosus Sm. ♀, s. & c. p.; (15) H. tegularis Rob. ♀, s. & c. p.; (16) H. confusus Sm. ♀, s. & c. p., ab.; (17) H. stultus Cr. ♀, s. & c. p., ab.; (18) Agapostemon radiatus Say, ♀, s.; (19) Augochlora confusa Rob. ♀, s. & c. p., freq.; (20) Sphecodes ranunculi Rob. ♀, s.; (21) S. dichrous Sm. ♀, s., freq.; (22) S. mandibularis Cr. ♀, s.; (23) S. stygius Rob. ♀, s.; (24) Andrena vicina Sm. ♀, s.; (25) A. pruni Rob. ♂ ♀, s. & c. p., in cop.; (26) A. sayi Rob. ♂ ♀, s. & c. p., freq.; (27) A. erythrogastra Ashm. ♂, s.; (28) A. cressonii Rob. ♂ ♀, s. & c. p., freq.; (29) A. bipunctata Cr. ♂ ♀, s. & c. p., ab.; (30) A. personata Rob. ♂ ♀, s., ab. (31) A. claytoniae Rob. ♀, s. & c. p; (32) A. forbesii Rob. ♀, s.; (33) A. hippotes Rob. ♀. s. & c. p.; (34) A. mariae Rob. ♀, s.; (35) Colletes inaequalis Say ♂; *Vespidae:* (36) Polistes metricus Say, s.; *Eumenidae:* (37) Odynerus tigris Sauss., s.

Diptera—*Stratiomyidae:* (38) Stratiomyia quaternaria Lw., s., freq.; *Empididae:* (39) Empis otiosa Coq., s., freq.; (40) Rhamphomyia priapulus Lw., s.; *Bombylidae:* (41) Bombylius major L., s.; (42) B. pulchellus Lw., s.; *Conopidae:* (43) Myopa vesiculosa Say, s., freq., in cop.; *Syrphidae:* (44) Paragus bicolor F.; (45) Psilota buccata Mcq.; (46) Chrysogaster pictipennis Will.; (47) Chilosia sp.; (48) C. capillata, Lw., freq.; (49) C. versipellis Will., freq.; (50) Mesograpta marginata Say; (51) M. geminata Say; (52) Myiolepta strigillata Lw., freq.; (53) Brachyopa vacua O. S.; (54) Eristalis aeneus F., freq.; (55) E. dimidiatus Wd.; (56) E. transversus Wd.; (57) Helophilus latifrons Lw.; (58) Criorhina umbratilis Will.; (59) C. decora Mcq.; (60) Syritta pipiens L.; *Tachinidae:* (61) Gymnosoma fulginosa R. D.; (62) Jurinia apicifera Wlk.; (63) Peleteria robusta Wd., freq.; (64) Gonia frontosa Say; *Muscidae:* (65) Graphomyia americana R. D.; (66) Lucilia sp.; (67) L. caesar L.; (68) L. cornicina F.; (69) L. latifrons Schin., freq.—all s. or f. p.

Lepidoptera—*Rhopalocera:* (70) Pyrameis huntera F.; (71) Phyciodes nycteis Db.-Hew.; (72) Thecla melinus Hbn.; (73) Lycaena pseudargiolus Bd.-Lec.; (74) Nysoniades juvenalis F., freq.; (75) N. martialis Scud.; *Sphingidae:* (76) Hemaris thysbe F.—all s.

LONICERA L.—The flowers of honeysuckles present quite a variety of forms and adaptations. In the case of zygomorphous flowers in general, except those like Heracleum, I have advanced the proposition[1] that the flowers were originally adapted to bees, or principally visited by them. Correlated with this is the proposition that hawk moths and humming birds, from the fact that they do not alight upon the flower, do not have any influence in producing irregularity, and that the irregular flowers which are adapted to them were monopolized by them after they had been changed to an irregular form by bees. I assume that the flowers have become sternotribe from the fact that bees have been in the habit of landing upon the stamens and style. While the hawk moths do not tend to produce irregular flowers, it does not follow that their influence is to turn such flowers back to a more regular form, for the limitation of the pollen contact to the undersides of their bodies is clearly advantageous to the flowers. I suppose then, that the irregular sphingophilous species were originally bumble-bee flowers which have been usurped and further modified by hawk moths. The bumble-bee

[1] Zygomorphy and its causes. BOT. GAZ. 13: 229. 1888.

flowers may have come from the short-tube forms, which were adapted to the less specialized bees or to wasps. Or, the wasp-flowers may have come from those adapted to bumble-bees by a process of retrograde metamorphosis, as in the case of Scrophularia. If the bird-flower, *L. sempervirens*, came from an irregular form, I do not understand how it has lost it. However, the more regular form has the effect of lengthening the tube and of excluding the intruders which might remove the pollen.

The irregular flowers have four lobes above forming a vexillum — one of the many cases Henslow's theory will not account for — and a single lobe below, which projects forwards and assists in supporting the visitor, or is reflexed.

The flowers of most species are more or less horizontal, and this is the typical position, if my theory is correct. Some are nearly erect and others pendulous.

The corolla tube varies in length from 7^{cm} in *L. longiflora* (Delpino 7) to $3–4^{mm}$ in *L. xylosteum* (Müller 5). The long-tubed species are adapted to hawk moths, those of mid-length to bumble-bees, while the short-tubed species are adapted to the smaller bees, or even in one case to wasps, as *L. alpigena* (Müller 14). The last case is questioned by Schulz (29). MacLeod and others have been so confused by observing the frequent visits of bees to wasp-flowers that they have been inclined to abandon that category. But the wasp-flowers always show a proportion of wasps that is not equaled in any other flowers.

The usual color appears to be yellowish, the old flowers inclining to turn purplish, or white with rosy or purplish tints. The sphingophilous species are commonly whitish, the ornithophilous *L. sempervirens* red, as in all of our bird-flowers — *Tecoma radicans*, *Aquilegia Canadensis*, *Lobelia cardinalis*, *Castilleia coccinea* — while *L. alpigena* is reddish brown, as in Scrophularia.

The sphingophilous species open at night and emit a strong scent at that time, but the ornithophilous *L. sempervirens* is said by Hancock[2] (34) to be scentless.

[2] This author has a good deal to say about certain wonderful pollen-holding structures on the head of *Trochilus colubris*. Unfortunately, they are in the wrong

According to Kerner (31), in the twining honeysuckles (*L. caprifolium*, *etrusca*, *grata*, *implexa*, *periclymenum*, etc.) nectar is secreted in the lowest part of the tube, while in the non-twining ones (*L. alpigena*, *nigra*, *xylosteum*, etc.) it is secreted in an expansion above the base. In the sphingophilous species the nectar is protected from unbidden guests by the long, narrow tube; in the shorter, wider tubed species it is protected by hairs upon the filaments and the inner wall of the corolla. Under conditions unfavorable for the visits of hawk moths, nectar accumulates in the long-tubed species until a part of it becomes accessible to some long-tongued intruders.

Some observers have found in the tubes holes which, they imagined, were made by bees. Müller saw *L. coerulea* perforated by *Bombus mastrucatus*. Schneck (27) saw *Megachile brevis* (?) cutting circular pieces out of the tubes of *L. sempervirens*, as he says, to obtain the nectar. I have seen this bee cut such pieces out of the corollas of *Œnothera fruticosa*, *Cassia Chamaecrista* and *Ruellia ciliosa*, but she carried them away to use in her nests.

The anthers are exposed so that the pollen is accessible to a number of intruders, principally *Andrenidae* and *Syrphidae*, which may collect it or feed upon it, usually doing harm, though they may sometimes effect cross- or self-pollination. Meehan (22, etc.),who has observed only this kind of insect visits to a cultivated exotic species, concludes from it that the presence of nectar is of no significance as an adaptation for insect pollination.

The statements in regard to dichogamy, or other adaptations for cross-pollination, are remarkably conflicting. *L. caprifolium* is homogamous according to Müller (5), slightly proterogynous according to Kirchner (28). *L. xylosteum* is homogamous (Müller) and proterogynous with spontaneous alternating movements of stamens and style (Kerner). *L. coerulea* is proterogynous (Hildebrand 2, Ricca 4) and homogamous (Müller 15). Müller calls *L. periclymenum* homogamous, and supposes that cross-pollination is favored by the stigma being in advance of

place, for all of our bird-flowers whose ranges approach that of the ruby-throat, with the exception of *A. Canadensis*, strike the bird on the upper side. The case is imaginary, anyhow.

the anthers; Knuth (38) shows that, as a result of the correlated movements of the style and stamens, the anthers are exposed in the way of the visitor on the first evening and the stigma on the second. *L. alpigena* is homogamous (Müller) and proterogynous (Kerner). In one place Meehan says *L. Japonica* is proterogynous (23), in another homogamous (36). *L. nigra* and *Tatarica* are homogamous (Müller). *L. Iberica* is slightly proterogynous (Kirchner 28). The common woodbine (?) and *L. sempervirens* are proterandrous (Schneck 27). In *L. alpigena*, *nigra*, etc., according to Kerner, there occurs a change of position of the stamens and stigma by which they are placed in the way of the visitors at different times, probably as in *L. periclymenum*.

	Sphingidae	Other Lepidoptera	Bombus	Other bees	Wasps	Diptera	Other insects	Trochilus
SPHINGOPHILOUS.								
caprifolium, Germany, Müller	6	4						
Flanders, MacLeod	1							
periclymenum, Germany, Müller	6		1					
Northfrissian Islands, Knuth	5	1	2		1	7		
Flanders, MacLeod	1		2					
———, White		×						
Scotland, Willis			1					
Holland, Heinsius			1					
japonica ———, Meehan				1				
BOMBUS-FLOWERS.								
coerulea, Alps, Müller	1	2	6	8	3	3	2	
Alps, Ricca			1					
xylosteum, Germany, Müller,			2	1		2		
Alps, Ricca			×	×		×		
iberica, Hohenheim Bot. G., Kirchner			1	1				
sullivantii, Illinois			2	1		1		1
MELITTOPHILOUS.								
tatarica, Germany, Müller				3		1		
Northfrissian Islands, Knuth						1		
nigra, Alps, Müller				2				
WASP-FLOWERS.								
alpigena, Alps, Müller	1	1	3	4	2	2		
Tyrol, Schulz	2		×	×	4	×		
ORNITHOPHILOUS.								
sempervirens, Illinois								1

The preceding table gives the insect visitors of *Lonicera* as observed in different regions.

LONICERA SULLIVANTII Gray.—This honeysuckle occurs in two places in my neighborhood, on creek banks. The flowers are in clusters at the ends of the branches and hold a more or less horizontal position. Newly opened ones are rather pale yellow, but later show a purplish tinge. The upper lip consists of four lobes which are turned up like a vexillum; the lower consists of a single lobe. Bees land upon the stamens and style, which are exserted about 7^{mm}. The corolla tube measures $14–18^{mm}$ in length. Nectar is secreted and retained in a slight gibbosity near the base of the tube.

The flowers are homogamous, the stigmas are receptive a little before the opening of the anthers, but the proterogyny is too slight to be of much importance. The stigma is somewhat in advance of the anthers, but not enough always to prevent spontaneous self-pollination.

I have observed flowers opening as early as 4 o'clock in the afternoon, the anthers beginning to open at 5:15 o'clock, and most of the flowers shedding pollen by 5:30. These flowers were visited by *Bombus virginicus* Oliv. ♀, three; *Anthophora ursina* Cr. ♀ and the humming bird, *Trochilus colubris* L., so that there was abundant opportunity for them to be effectually pollinated before sundown. The work of pollination may be completed by hawk moths in the evening, or when the bees and humming birds return next morning.

The blooming season is short; May 15–June 6. I have seen the flowers visited in the morning by:

Bees: (1) Bombus virginicus Oliv. ♀, s., freq.; (2) B. americanorum F. ♀, s.; (3) Anthophora ursina Cr. ♀, s. & c. p., freq.

Birds: (4) Trochilus colubris L., s., freq.

Flies—*Syrphidae:* (5) Pipiza femoralis Lw., f. p., one.

On the pollination of Lonicera see:

(1) Sprengel, Das entdeckte Geheimniss 120. 1793. *L. xylosteum, caprifolium.*—(2) Hildebrand, Geschlechter-vertheilung bei den Pflanzen 18. 1867. *L. coerulea.*—(3) Axell, Om anordningarna för de fanerogama väx-

ternas befruchtning 37, 64–5, 98. 1869. *L. coerulea.*—(4) Ricca, Osservazioni sulla fecondazione incrociata dei vegetali alpini e subalpini. Atti Soc. Ital. Sci. **14**: 255–6. 1871. *L. nigra, xylosteum, coerulea.*—(5) Müller, Befruchtung der Blumen 361–4. 1873. *L. periclymenum, caprifolium, tatarica, xylosteum.*—(6) White, The influence of insect agency on the distribution of plants. Am. Nat. **7**: 271. 1873. *L. periclymenum.* (Just **1**: 377.)—(7) Delpino, Ulteriori osservazioni II. **2**: 44, 114, 179, 276, 336; Atti Soc. Ital. Sci. **16**: 192, 262, 327. 1873; **17**:—. 1874. *L. caprifolium, coerulea, xylosteum, periclymenum, longiflora, sempervirens.* (Just **2**: 893.)—(8) Lubbock, British wild flowers in relation to insects 108–10. 1875. *L. caprifolium, periclymenum, xylosteum.*—(9) Gray, Darwin on the effects of cross and self-fertilization in the vegetable kingdom. Am. Journ. Sci. & Arts III. **13**: 133. 1877. (Just 5^{1}: 743.)—(10) Bonnier, Les Nectaires. Ann. Sci. Nat. Bot. VI. **8**: 72, 86, 138–9, 187, 192. 1878. *L. fragrantissima, periclymenum, sempervirens, standeskii.*—(11) Errera et Gevaert, Sur la structure et les modes de fécondation des fleurs. Bull. Soc. Bot. Belgique **17**: 106. 1878. *L. caprifolium.*—(12) Dodel-Port, Die Liebe der Blumen. Illustr. Pflanzenleben Lief. 4/5: 185–240. 1880. *L. periclymenum.* (Just 8^{1}: 183.)—(13) Gray, Structural Botany 217. 1880. *L. sempervirens,* ornithophilous.—(14) Müller, Die Entwickelung der Blumenthätigkeit der Insekten. Kosmos **9**: 272. 1881. *L. alpigena.* (Just 8^{2}: 148.)—(15) Müller, Alpenblumen 394–9. 1881. *L. nigra, alpigena, coerulea.* (Just 7^{1}: 102.)—(16) Dufour, Existence de tensions chez certaines fleurs 42–6. Dissertation inaug. Lausanne. 1882. *L. ledebouri.* (Just 9^{1}: 500.)—(17) Müller, Weitere Beobachtungen **3**: 75. 1882. *L. periclymenum.* (Just 9^{1}: 526.)—(18) Müller, Fertilization of Flowers 293–9. 1883. *L. coerulea, periclymenum, caprifolium, tatarica, nigra, xylosteum, alpigena.*—(19) Focke, Nägeli's Einwände gegen die Blumentheorie, erläutert an den Nachtfalterblumen. Kosmos **14**: 299. 1884. *L. caprifolium, periclymenum.* (Just 12^{1}: 668.)—(20) Loew, Blumenbesuch von Insekten an Freilandpflanzen. Jahrbuch Bot. Gartens Berlin **3**: 78, 90. 1884; **4**: 98–9. 1886. *L. caprifolium, periclymenum, alpigena.*—(21) Ingen, Bees mutilating flowers. Bot. Gaz. **12**: 229. 1887. *L. parviflora, grata.* (Just 15^{1}: 413–4.)—(22) Meehan, Adaptation in the honeysuckle and insect visitors. Bot. Gaz. **13**: 237–8. 1888. (Just 16^{1}: 555.)—(23) Meehan, Contributions to the life histories of plants. II. Proc. Acad. Nat. Sci. Phila. **1888**: 279–83. *L. japonica.* (Just 16^{1}: 538.)—(24) Meehan, Adaptation in the honeysuckle and insect visitors. Proc. Am. A. A. S. 1888: 284. (Just 17^{1}: 548.)—(25) Noll, Ueber die normale Stellung zygomorpher Blüthen und ihre Orientirungsbewegungen. Arbeiten Bot. Institut Würzburg **3**: 189–252. 1888. (Just 13^{1}: 752.)—(26) Pammel, On the pollination of *Phlomis tuberosa* and the perforation of flowers. Trans. St. L. Acad. Sci. **5**: 254, 275. 1888. *L. caprifolium, flava, glauca, grata, sempervirens,* perforation.—(27) Schneck, Mutilation of flowers by insects. Bot. Gaz. **13**: 39. 1888. *L. sempervirens.*

(Just 16¹ : 538.)—(28) Kirchner, Beiträge zur Biologie der Blüten. Progr. 72 Jahresfeier K. Württemb. landwirtschaftl. Acad. Hohenheim 62. 1890. *L. caprifolium, iberica.* (Just 18¹ : 495.)—(29) Schultz, Beiträge zur Kenntniss der Bestäubungseinrichtungen und Geschlechtsvertheilung bei den Pflanzen 2 : 95–6. 1890. *L. alpigena.* (Just 18¹ : 519,)—(30) Fritsch, Caprifoliaceæ Engler u. Prantl, Die nat. Pflanzenfamilien IV. 4 : 159. 1891. (Just 19¹ : 409.)—(31) Kerner, Pflanzenleben 2 : —. 1891; Oliver translation 2 : —. 1895. *L. alpigena, caprifolium, etrusca, grata, implexa, nigra, periclymenum, xylosteum.* (Just 17¹ : 531; 18¹ : 485.)—(32) Heinsius, Over de bestuiving van bloemen der Nederlandsche flora door insecten. Bot. Jaarboek 4 : 115–16. 1892. *L. periclymenum.* (Just 20¹ : 484.)—(33) MacLeod, Bevruchting der bloemen van Vlaanderen. Bot. Jaarboek 5 : 390. 1893; 6 : 373. 1894. *L. caprifolium, periclymenum.*—(34) Hancock, Ornithophilous pollination. Am. Nat. 28 : 679. 1894. *L. sempervirens.*—(35) Loew, Blütenbiologische Floristik 26, 42, 147, 249–50. 1894. *L. alpigena, coerulea, caprifolium, iberica, periclymenum, xylosteum.*—(36) Meehan, Contributions to the life histories of plants. XI. Proc. Acad. Sci. Phila. 1894 : 169–71. *L. japonica.* (Just 22¹ : 285.)—(37) Knuth, Blumen und Insekten auf den nordfriesischen Inseln 80, 156, 193. 1894. *L. periclymenum.*—(38) Knuth, Nachuntersuchung der Blüteneinrichtung von *Lonicera periclymenum* L. Bot. Centralblatt 60 : 41–4. (Just 22¹ : 278.)—Knuth, Weitere Beobachtungen über Blumen und Insekten auf den nordfriesischen Inseln. Schr. Nat. Ver. Schleswig-Holstein 10 : 234–5, 254, 256. 1895. *L. periclymenum, tatarica.*—(40) Willis and Burkill, Flowers and insects in Great Britain. Ann. Bot. 9 : 240. 1895. *L. periclymenum.*

HELIANTHUS DIVARICATUS L.—The following visitors were observed on August 8, 14, 17, 21, 24, 27, 29, 31, and September 2, 4, 7, and 10:

Bees—*Apidae:* (1) Bombus americanorum F. ♂, s.; (2) B. scutellaris Cr. ♀, s. & c. p.; (3) B. separatus Cr. ♂, s.; (4) Melissodes obliqua Say ♀, s. & c. p., freq.; (5) M. coloradensis Cr. ♂ ♀, s. & c. p., freq.; (6) M. americana Lep. ♂ ♀, s. & c. p., freq.; (7) M. nivea Rob. ♂, s., freq.; (8) M. pennsylvanica Lep. ♀, s. & c. p.; (9) M. simillima Rob. ♂, s.; (10) M. aurigenia Cr. ♂, s.; (11) Megachile mendica Cr. ♂, s.; (12) M. optiva Cr. ♀, s.; (13) Coelioxys totonaca Cr. ♀, s.; (14) C. 8-dentata Say ♂, s.; (15) C. sayi Rob. ♂, s.; (16) Epeolus concavus Cr. ♀, s.; (17) E. lunatus Say ♀, s.; (18) E. donatus Sm. ♂ ♀, s., freq.; (19) E. compactus Cr. ♂, s., freq.; (20) E. pusillus Cr. ♂, s.; (21) E. nevadensis Cr. ♀, s.; (22) E. cressonii Rob. ♂ ♀, s.; (23) Panurginus labrosiformis Rob. ♀, s. & c. p.; (24) P. rugosus Rob. ♀, s. & c. p.; (25) Halictoides marginatus Cr. ♂ ♀, s. & c. p., freq.; *Andrenidae:* (26) Halictus pectoralis Sm. ♀, c. p., freq.; (27) H. ligatus Say ♂ ♀, s. & c. p., freq.; (28) Augochlora confusa

Rob. ♂ ♀, s. & c. p.; (29) Colletes americanus Cr. ♂ ♀, s.; (30) Andrena helianthi Rob. ♂, s.; (31) A. pulchella Rob. ♀, s. & c. p.

Diptera — *Bombylidae:* (32) Exoprosopa decora Lw.; (33) Anthrax palliata Lw.; (34) A. halcyon Say; (35) Sparnopolius fulvus Wd., ab.; (36) Systoechus vulgaris Lw.; *Conopidae:* (37) Zodion fulvifrons Say, freq.; (38) Z. nanellum Lw.; *Syrphidae:* (39) Eristalis transversus Wd.; *Anthomyidae:* (40) Proboscimyia siphonina Bigot — all s.

Lepidoptera — *Rhopalocera:* (41) Phyciodes nycteis Db.-Hew.; (42) Catopsilia eubule L.; (43) Colias philodice Gdt.; (44) Pamphila cernes Edw. — all s.

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PYROLA APHYLLA: A MORPHOLOGICAL STUDY.

THEO. HOLM.

(WITH PLATE XVII)

IT would seem very strange if there really existed a truly leafless species in a genus like Pyrola, of which all the other representatives are not only leafy, but even evergreen. One might think at a first glance that the lack of proper leaves would influence the species so much in its mode of growth, as a saprophyte or parasite, as to warrant its segregation from the genus Pyrola. Entire genera devoid of proper leaves are not so very scarce in the phanerogams, but in no case does there exist a genus which contains autophytic, saprophytic, and parasitic species. There are several families, on the other hand, in which we meet with both leafy and leafless genera; for instance, the apparently leafless Epirhizanthes among the Polygalaceæ; Voyria and Voyriella among the Gentianaceæ; Monotropa, Sarcodes, Pterospora, etc., among the Pyrolaceæ; Neottia, Corallorhiza, etc., among the Orchidaceæ; and, finally, Baillon's remarkable Geosiris among the Iridaceæ.[1] These instances are familiar to us, but we are unable to cite any genus which has both autophytic and parasitic species, with the exception, as it has been believed, of Pyrola. The fact is, however, that, notwithstanding statements made by such prominent authors as DeCandolle and Hooker, the plant is not by any means aphyllous, but has evidently received its name for the same reason that Galax was named *aphylla* by Linnæus, the original specimens having but imperfectly represented the species. Thus has DeCandolle described our Pyrola as "foliis veris nullis" and as a "species absentia foliorum spectabilis et quasi ad Monotropeas vergens;" while Hooker goes still further in stating "folia omnino nulla."

[1] For references consult the bibliography appended to this article.

The figure in Hooker's work shows distinctly that his specimen was but fragmentary. Nuttall, shortly after Hooker, corrected this mistake by stating "occasionally it produces, near the root and on infertile shoots, a few small, ovate, or lanceolate greenish leaves." It is very surprising that Gray in later years should still have described it as "leafless, doubtless parasitic," and as "a peculiarly interesting plant on account of its living the parasitic life of the Monotropeæ." To Nuttall, therefore, belongs the credit of having discovered the leaves of this singular plant which Smith at first described as destitute of leaves, and accordingly named it "leafless wintergreen." These contradictory statements, however, have led the writer to investigate the matter fully, after having secured some excellent living specimens from Amador county, California, which were kindly collected by Mr. Geo. Hansen. Besides confirming Nuttall's observations of the presence of proper leaves, I have detected a few peculiarities which will be presented in this paper.

The accompanying *fig. 1* represents a mature and very carefully collected specimen of our plant, and we notice here several underground shoots, of which one bears a rosette of leaves at its apex (*L*), in the same manner as in other species of Pyrola. In considering the leaves by themselves, they are, as described by Nuttall, rather small, but provided with a distinct petiole and a blade, varying from lanceolate to broadly ovate, obtuse, or slightly pointed (*figs. 2, 3*). These leaves were green, and the chlorophyll became still more conspicuous by immersing the leaves in strong alcohol, which readily assumed a deep green color, which afterwards turned dark brown from the large content of tannin in the cell sap. As regards the minute structure of these leaves, we did not observe any peculiarity by which our species might be separated from the other species of Pyrola, and there is absolutely no character whatever that might warrant the supposition that our plant lives a saprophytic or a parasitic life. The epidermis is perfectly normal and covered by a thick and wrinkled cuticle, common to evergreen leaves; stomata are present on both faces of the blade, but are most numer-

ous on the lower surface; no hairs or glands were observed on either face. The chlorophyll-bearing tissue is differentiated into a palisade tissue of about two layers on the ventral face of the blade, and an ordinary pneumatic tissue, the cells of which are roundish and loosely connected with each other, leaving intercellular spaces of quite considerable width. The mestome bundles possess all the elements as found in other dicotyledons, and are supported by a collenchymatic tissue which makes the nerves very prominent on the lower surface of the leaf.

Besides these completely developed leaves, our plant possesses also scale-like ones, which are much more numerous, covering not only the underground shoots, but also the base of the inflorescences (i^1 and i^2 in *fig. 1*). Very characteristic of *Pyrola aphylla* is the profuse development of axillary buds, which are readily observed upon the underground stems and at the base of the aerial floral and vegetative shoots. These axillary buds, however, are restricted to the scale-like leaves, since I failed to detect any such in the axils of those provided with petiole and blade. The first two leaves of such axillary buds are situated to the right and left of the diminutive bud axis, while the third and fourth appear almost in regular alternation with these, those following, on the contrary, forming an ordinary spiral.

Upon examining the stem underground we notice in our figure (*fig. 1*) two long branches (b^1 and b^2) with elongated internodes, which show an ascending curvature from the roots, from which point they creep horizontally underneath the surface of the soil, until they finally push up through it, either terminated at once by the inflorescence or first by a rosette of proper leaves. It is easily understood that it has been the collecting of just such underground branches, terminated by inflorescences and not preceded by a rosette of leaves, which has misled botanists to consider our plant as aphyllous and parasitic. The anatomical structure of these underground branches, which constitute the rhizome of *Pyrola aphylla*, is, however, that of a true autophyte,

showing the well-known elements of normally developed tissues. There is a wrinkled cuticle covering the thick-walled epidermis, inside of which follows a heavy layer of cork parenchyma of rather closely packed polyhedric cells, which border on a thin-walled endodermis. This endodermis encircles the leptome and hadrome, the last of which has distinctly lignified cell walls, while an ordinary pith occupies the innermost part of the central cylinder. Tannin was observed in abundance in the cells of the bark and epidermis.

In comparing the structure with that of the aerial flower-bearing stem, we notice only a few divergencies. The bark contains chlorophyll, and a closed ring of stereome is developed around the central cylinder, of which the pith occupies the larger part. In combining these anatomical features of the leaves, the aerial and subterranean stem, there is so far no indication of our plant being a parasite or saprophyte or in any other way differing from the other species of Pyrola.

The last organ of the plant, which is not to be overlooked, is the root, the main and the adventitious. Only a part of the main root was preserved in our specimens (*R* in *fig. 1*), and it is by no means certain whether this dark colored and slightly branched root is the main root or merely a branch. It is from this root, however, that the subterranean shoots have developed as true root-shoots, a fact that is readily observed in *fig. 1*. We not only observe that the two long underground branches proceed directly from this root, but also the development of two dense clusters of shoots with more or less curved apices, all of which are beginning to develop into underground creeping stems, like the two larger ones described above (b^1 and b^2). Our plant shows then a strongly pronounced vegetative propagation, which perhaps has reached a higher development in this than in any other species of Pyrola. Adventitious roots were also observed. They are rather thin and show only a few ramifications. Their position is somewhat peculiar, since they break out a short distance above the scale-like leaves, and either to the right or left of the axillary buds.

Besides the fact that we have not been able to detect any haustoria upon the roots, the interior structure is sufficient to show the nature of our plant, whether it is an autophyte, a parasite, or a saprophyte. The presence of green leaves, however, is sufficient to determine the question whether the plant is a saprophyte, and a general consideration of the anatomy of the roots will suffice to convince any observer that *Pyrola aphylla* is no parasite either. Root-hairs are developed from the epidermis, inside of which there is a hypoderm of rather large cells, which surrounds a bark-parenchyma of normal structure and packed with starch, but without any trace of fungal mycelia. The endodermis is perfectly normal and surrounds, together with the pericambium, the five groups of leptome, alternating with a corresponding number of hadrome groups, while the innermost part of the central cylinder is occupied by a few strata of conjunctive tissue.

Pyrola aphylla shows, therefore, a striking ability to propagate by means of axillary buds developed upon the underground stems, and likewise by adventitious buds which push out very freely from the roots. Propagation by seeds is not excluded, and each capsule contains a large number of very minute, but mature seeds. By bringing these facts together with the anatomical structure of the vegetative organs, it may be seen that our plant shows no sign of living a parasitic life or even a saprophytic one, but that it is a true autophyte. This becomes the more evident when we compare our species with its nearest relatives, of the genus Pyrola itself, of Moneses and Chimaphila.

From the writings of Irmisch we have learned that a similar reproduction by root-shoots takes place in *Pyrola secunda*, *P. chlorantha*, and in *Moneses uniflora*. Besides, we have succeeded in finding similar shoots from the roots of *Pyrola picta*, *Chimaphila umbellata*, and *C. maculata*. The morphological characters of the vegetative organs of the species of Pyrola depend especially upon the development of the proper leaves, whether they precede or are contemporary with the flowers. According to Irmisch, some of the leaves develop in the same year as

the flowers in *Pyrola minor*, while in *P. secunda* and *P. rotundifolia* all the proper leaves have appeared during the year previous to the flowering. It is to be noted that a few rudimentary scale-like leaves occur also in these species, preceding and succeeding the proper ones. While the inflorescence is strictly terminal in the above mentioned species of Pyrola, Irmisch observed also lateral ones in *P. chlorantha*, and it is interesting to notice that these lateral inflorescences possessed only undeveloped leaves at their bases.

In our plant, *Pyrola aphylla*, we have both terminal and lateral inflorescences, the terminal being, perhaps, constantly preceded by normal leaves (*L* in *fig. 1*), which appeared during the year previous to the flowering, agreeing in this respect with *P. secunda*, *P. chlorantha*, and *P. rotundifolia*. No axillary buds were observed in the axils of the green leaves, a fact that furnishes another illustration of the great resemblance which exists in the vegetative organs of Pyrola. The most conspicuous character of *P. aphylla*, if we merely compare the vegetative organs, lies in the scanty foliage of proper leaves, which, however, has become in part replaced by an unusually large number of scale-like ones.

If we compare our plant with Chimaphila, of which we have examined *C. umbellata* and *C. maculata*, we shall find many analogies. We have already stated that we observed root-shoots in both of these species, and *fig. 4* shows the base of an old plant of *C. maculata*, with a young shoot pushing out from one of the lateral roots (*R. S.*). The species of Chimaphila also develop long horizontally creeping and branching rhizomes, which in a specimen of *C. umbellata* reached a length of two-thirds of a meter. The aerial shoots of Chimaphila differ, however, from those of *Pyrola aphylla* and the other species mentioned above, in that the proper leaves support buds, which develop during the following year.

In respect to the absence of scale-like leaves at the base of the inflorescence and above the proper leaves, Chimaphila agrees with several of the species of Pyrola, but not with *P. minor* and

P. aphylla. It seems, on the whole, that these members of the Pyrolaceæ, Pyrola, Moneses, and Chimaphila, form a very natural group by themselves, if we consider their morphological characters, and their floral and vegetative structures. While *Pyrola secunda*, *P. aphylla*, *P. picta*, and *P. chlorantha* are the only species which have been observed to produce root-shoots, we should not feel surprised if this be the case also with all the other species, as in Moneses and Chimaphila. But we doubt very much whether any of these genera live as true saprophytes, although the supposed related Monotropeæ are known to live as such.

There is yet another point of interest in the life history of the Pyrolaceæ which we should like to touch upon, even though it may seem somewhat foreign to the main subject of this paper. The germination of the Pyrolaceæ is almost unknown, and with the exception of *Pyrola secunda* and Monotropa, none have been examined at this early stage of development. In his description of the germination of *P. secunda*, Irmisch points out the lack of two opposite cotyledons, while a series of about ten scale-like leaves, all underground, precede the proper ones. These rudimentary leaves were pale, and they were situated at some distance from each other upon the underground part of the stem. Buds were observed in the axils of these leaves, and some of them had already pushed out so as to form ascending shoots. Secondary roots were seen in several cases to break out above a number of these buds. This manner of germinating, with no proper cotyledons, is rather rare among the dicotyledons, but is especially characteristic of the parasitic forms, Orobancheæ (excepting Lathræa), Balanophoreæ, Cuscuta, etc., besides the saprophytic genus Monotropa. It seems very strange that *Pyrola secunda* should exhibit a similar manner of germination, since it does not otherwise behave as a saprophyte. It is the more surprising, also, in view of the fact that *Chimaphila maculata* germinates in the same way as the majority of the other dicotyledons. We succeeded in finding a number of seedlings of this species in the month of July, while we were digging out some

mature specimens for the purpose of examining the rhizomes. These seedlings, one of which is figured (*fig. 5*), showed then a long hypocotyl (*H* in the figure), two normal green cotyledons (*Cot.*) which were almost sessile, the blade oblong or approximately obovate. The first two leaves, succeeding the cotyledons, had a distinct petiole and an oblong blade, while the third showed the first traces of dentation and represented a tridentate leaf. The main root (*R*) was long, slightly branched, and covered with root-hairs; one pair of secondary roots (*r*) were developed just above the main one, but in no other place were such secondary roots observed upon these minute seedlings. Although *Chimaphila umbellata* is not uncommon in the vicinity of Washington, we have not yet been able to detect its seedlings, but it is not likely that they differ from those of *C. maculata*, as the manner of growth of these species is exactly the same. The species of Pyrola and Moneses demonstrate, on the contrary, a somewhat different mode of growth, which perhaps may be visible at the earliest stages of their development during germination.

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BIBLIOGRAPHY.

1. ALEFELD: Ueber die Familie der Pyrolaceen. Linnæa **12**: 13. 1856.

2. BAILLON, H.: Une Iridacée sans matière verte. Bull. mens. de la Soc. Linnéenne de Paris, no. 145. 1149.

3. DECANDOLLE, P.: Prodromus systematis naturalis regni vegetabilis. 7: 773. 1838.

4. GRAY, ASA: Botany of California **1**: 461. 1876.

5. GRAY, ASA: Synoptical Flora of North America 2^1: 48. 1886.

6. HOOKER, W. J.: Flora Boreali-Americana **2**: 48. 1840.

7. IRMISCH, THILO: Bemerkungen über einige Pflanzen der deutschen Flora. Flora **38**: 628. 1855.

8. KLOTZSCH, I. F.: Studien über die natürliche Klasse *Bicornes* L. Linnæa **24**: 3. 1851.

9. NUTTALL, THOMAS: Notices of new or rare plants in the natural Orders Lobeliaceæ, Campanulaceæ, Vaccinieæ, Ericaceæ collected in a journey over the continent of North America. Trans. Am. Phil. Soc. 8^3: 271. 1843.

10. RADIUS, JUSTUS: Dissertatio de Pyrola et Chimaphila 38. 1821.

11. REES, ABRAHAM: The Cyclopædia, 30: under Pyrola, by Smith.

12. WITTROCK, V. B.: Om Rotskott hos örtartade växter. Botaniska Notiser —: 21. 1884.

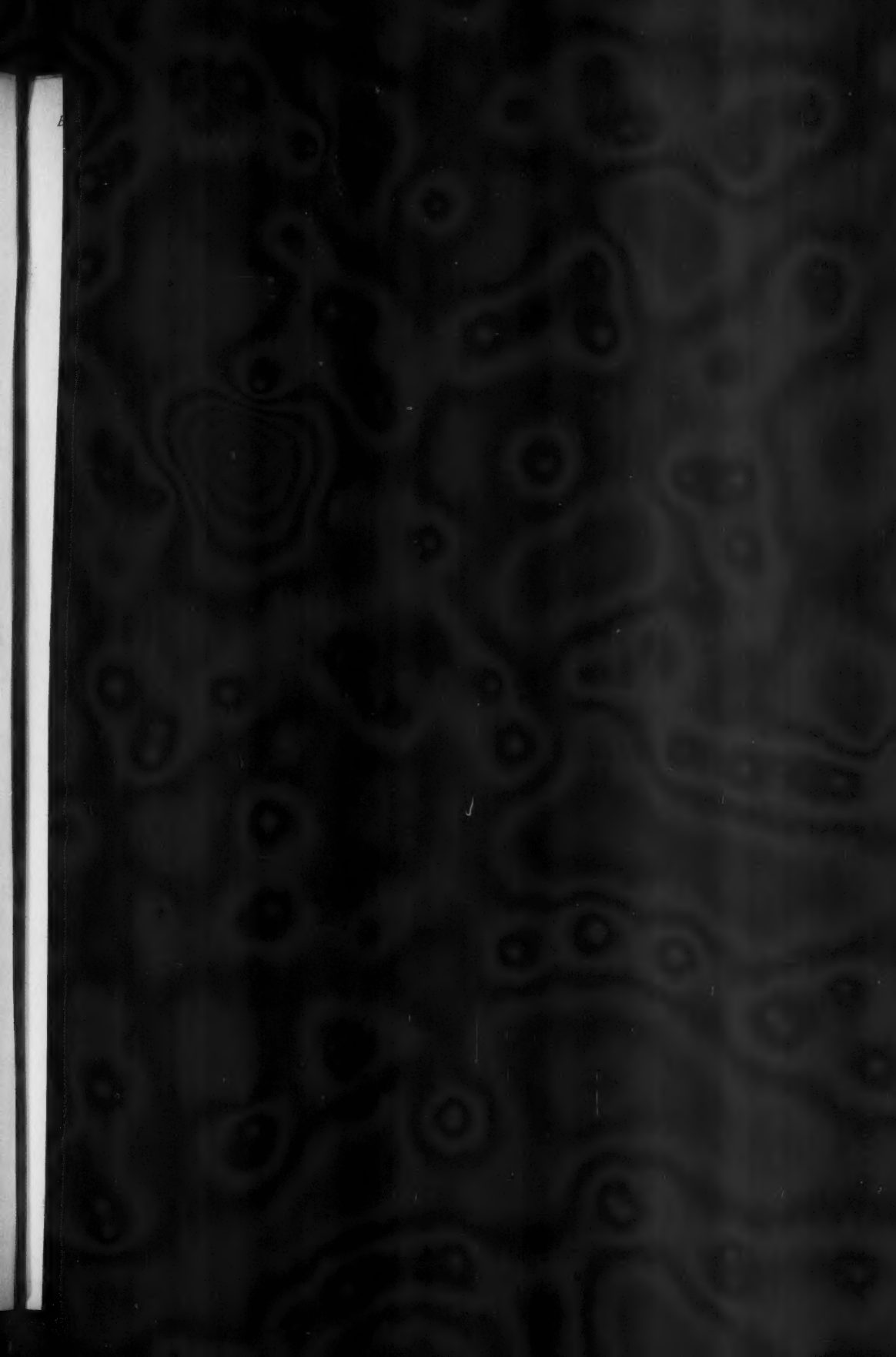
EXPLANATION OF PLATE XVII.

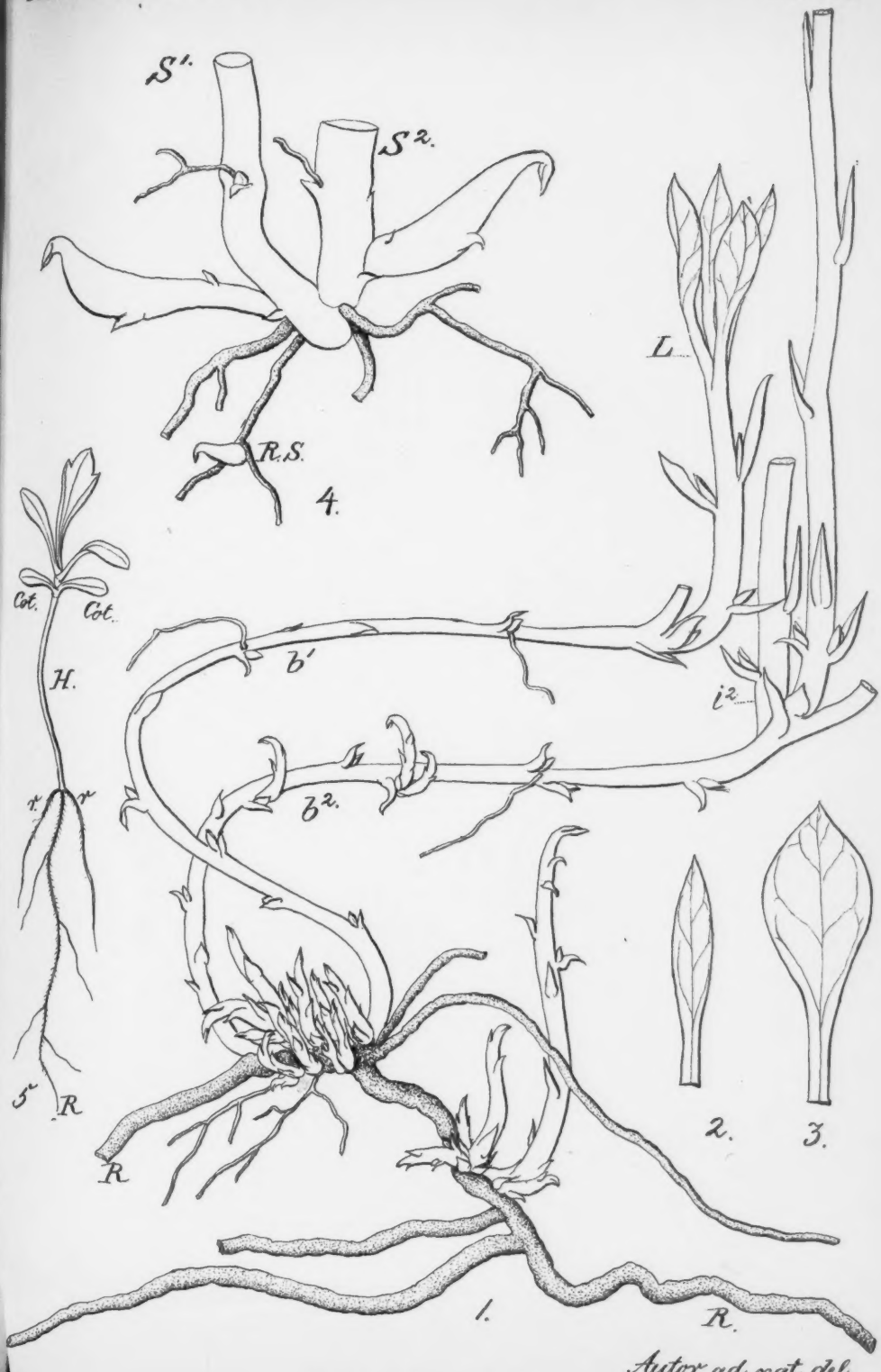
FIG. 1. A mature specimen of *Pyrola aphylla*. A rosette of proper leaves is to be seen at *L*; the base of two inflorescences at i^1 and i^2; b^1 and b^2 are the underground branches, which have developed from the root *R*, together with two clusters of small, ascending shoots. Natural size.

FIGS. 2 and 3. Leaves from the rosette. ×2.

FIG. 4. Rhizome of *Chimaphila maculata*, showing the base of two aerial stems (s^1 and s^2) with underground lateral shoots; a small root-shoot is to be seen at *R. S.* ×2.

FIG. 5. Seedling of *Chimaphila maculata*. *R* = the primary root; *r* and *r* = the first pair of secondary roots; *H* = the hypocotyl; *Cot.* = the cotyledons. ×3.





HOLM on PYROLA APHYLLA.

NOTES ON THE SALT MARSH PLANTS OF NORTHERN KANSAS.[1]

JOHN H. SCHAFFNER.

All through the central part of Kansas salt marshes and salt springs are quite common, and small salt licks are found in most parts of the state. Perhaps the largest of these marshes is the Big marsh, which stretches along Big Marsh creek from the northwest part of Cloud county through the southwest corner of Republic county, and for several miles into Jewell county. The writer visited this marsh in August 1897 in order to study the vegetation of the region. It is about seven miles long, and varies from a quarter to a mile in width. The marsh proper is a malodorous black bog, and large stretches are absolutely without vegetation. In the lower part of the marsh, in Cloud county, where the main observations were made, it is over a mile wide and there are places where one may walk for half a mile without finding a shoot of any kind. The salt, at a distance, looks like a light covering of snow. Although the weather had been very dry for a long time before my visit, a small stream of water was flowing through the shallow bed of the creek, and the surface of the marsh was quite moist and even muddy in places, being springy under foot. A beautiful mirage appeared in the distance over the marsh, which looked like a most inviting lake of pure water with green patches of vegetation. So complete was the resemblance that it was very difficult to believe that the phantom lake was not real water.

In Big marsh the conditions are still quite natural, large areas having never yet been fenced. However, it is said that the saline area has diminished much since the settlement of the country. The most striking feature is the utter barrenness of the district when compared with the surrounding country, and the

[1] Contributions from the botanical laboratory of Ohio State University. I.

absence of belts of trees and shrubs along the banks of the creek. The only woody plant seen growing on the outside of the marsh was *Amorpha fruticosa* L. Along the stream which flows through the marsh there are here and there patches of deposits somewhat raised above the general level and rather free from salt. These contain some plants which could not otherwise grow in the marsh. There are also sedges growing along the stream, and its muddy bottom is covered with a brown deposit of diatoms. The greater part of the marsh proper is entirely barren, but in some places there are isolated patches of salt marsh plants. On the outer portion beyond the barren area, there are often well marked zones of vegetation, especially where the ground rises gently from the marsh. Here the zones are very distinct, while in other places they may be crowded close together, and some zones may be omitted entirely.

The three sedges which grow in and along the stream are *Scirpus pungens* Vahl., *S. campestris* Britton, and *S. lacustris* L.

In the higher patches of alluvial deposit along the stream the following plants were collected: *Distichlis maritima* Raf., *Panicum Crus-galli* L., *Elymus Virginicus* L., *Spartina cynosuroides* Willd., *Rumex Britannica* L., *Polygonum Hydropiper* L., *P. Persicaria* L., *P. ramosissimum* Michx., *Amarantus chlorostachys* Willd., *Iva ciliata* Willd.

In the barren portion away from the stream, where the ground is a little higher and less salty, there were patches of *Polygonum ramosissimum* Michx. and *Distichlis maritima* Raf., or often both these plants were growing together, the Polygonum usually occupying the center, and the Distichlis forming a border around it.

On the outer margin of the barren area, where there was a gentle rise of the ground from the marsh outward, the following seven zones were determined.

FIRST ZONE: A few yards wide and composed entirely of *Distichlis maritima* Raf. On the inner side the grass was evidently having a hard struggle for a meager existence, and was mostly dead.

SECOND ZONE: A narrow strip a few yards wide composed of *Distichlis maritima* Raf., *Polygonum ramosissimum* Michx., and *Suæda diffusa* Watson. The Polygonum grows vigorously and forms the characteristic plant. This zone seems to be just above the outer limit of the ordinary inundations of the salt brine. Distichlis was abundant, but Suæda was only thinly interspersed, and there were many dead and dry specimens.

THIRD ZONE: This is a wide dry zone, with the following plants: *Distichlis maritima* Raf., characteristic and rather stunted in its growth; *Polygonum ramosissimum* Michx., quite rare, probably because of dryness; *Suæda diffusa* Watson, interspersed, quite common; *Iva ciliata* Willd., rare.

FOURTH ZONE: Usually about as wide as the last, and with the following plants: *Distichlis maritima* Raf., characteristic; *Polygonum ramosissimum* Michx., not very common; *Suæda diffusa* Watson, occasional; *Iva ciliata* Willd., not very common; *Sporobolus heterolepis* Gray, characteristic; *S. Texanus* Vasey, abundant in some places; *Atriplex expansa* Watson, rare; *Aster multiflorus* Ait., occasional.

FIFTH ZONE: A rather wide zone in which plants less characteristic of halophyte regions are trying to gain a foothold. *Iva ciliata* Willd. is the prominent plant of this zone. The following plants were collected: *Distichlis maritima* Raf., abundant; *Polygonum ramosissimum* Michx., not common; *Iva ciliata* Willd., characteristic; *Sporobolus heterolepis* Gray, common; *Sporobolus Texanus* Vasey, in some places; *Atriplex expansa* Watson, occasional; *Aster multiflorus* Ait., occasional; *Scirpus pungens* Vahl., common; *Hordeum jubatum* L., occasional; *Panicum virgatum* L., sometimes in patches; *Gaura parviflora* Dougl., occasional; *Ambrosia psilostachya* DC., rare.

SIXTH ZONE: The outer margin of the salt marsh proper, usually accompanied by a rise in the ground. Much like the fifth zone except that here *Ambrosia psilostachya* DC. is abundant, and gives the character instead of *Iva ciliata* Willd. The following plants were collected: *Distichlis maritima* Raf., *Polygonum*

ramosissimum Michx., *Iva ciliata* Willd., *Sporobolus heterolepis* Gray, *Hordeum jubatum* L., *Scirpus pungens* Vahl., *Panicum virgatum* L., *Gaura parviflora* Dougl., *Ambrosia psilostachya* DC. (abundant), *Glycyrrhiza lepidota* Nutt.

SEVENTH ZONE: The transition zone on the outer margin of the salt marsh proper where, beside occasional representatives of most of the plants found in the inner zones, the following plants are present: *Iva ciliata* Willd., *Sporobolus heterolepis* Gray, *Panicum virgatum* L., *Gaura parviflora* Dougl., *Ambrosia psilostachya* DC., *Glycyrrhiza lepidota* Nutt., *Aster multiflorus* Ait., *Helianthus annuus* L., *Erigeron Canadensis* L., *Xanthium strumarium* L., *Grindelia squarrosa* Dunal, *Desmanthus brachylobus* Benth., *Amorpha fruticosa* L., *Œnothera biennis* L., *Physalis lanceolata* Michx., *Euphorbia glyptosperma* Engelm., *Euphorbia marginata* Pursh, *Amarantus blitoides* Watson, *Elymus Virginicus* L., *Spartina cynosuroides* Willd., *Scirpus pungens* Vahl.

THE SEAPO, OR TUTHILL'S MARSH.

About eighteen miles east, and a little north of Big marsh, in the southeast part of Republic county, there is a salt marsh, on Little Marsh creek, which is commonly called Tuthill's marsh. This was visited the last of August 1897. It has suffered much from the cultivated soil on the high ground around it. Its margin is very irregular, both as to surface and vegetation. At present it is fenced and in pasture, and, although there are several hundred acres still without vegetation, it is much smaller than formerly and natural conditions are much disturbed. There are many irregular barren spots along the border, and no well marked zones as in the Big marsh.

In the stream flowing through the marsh diatoms were very abundant, but none of the green algæ common to the region were found. Along the stream *Scirpus campestris* Britton and *S. pungens* Vahl. were present, but *S. lacustris* L. was not seen.

On patches of overflow deposit were found *Distichlis maritima* Raf., *Polygonum ramosissimum* Michx., *P. Persicaria* L., *P. Hydro-*

piper L., *Amarantus chlorostachys* Willd., *Panicum Crus-galli* L., *Xanthium strumarium* L., and a single small willow, probably *Salix nigra* Marsh.

In isolated patches along the margin of the barren portion *Distichlis maritima* Raf., *Polygonum ramosissimum* Michx., and *Suæda diffusa* Watson, are usually the only plants present, but in some places *Hordeum jubatum* L. and *Sporobolus Texanus* Vasey come close to the border of the main barren. A little farther out *Iva ciliata* Willd. and *Atriplex expansa* Watson are common. Irregular patches, more or less inclosed by barren ground, contain *Distichlis maritima* Raf., *Polygonum ramosissimum* Michx., *Suæda diffusa* Watson, *Atriplex expansa* Watson, *Polygonum Hydropiper* L., *Solanum rostratum* Dunal, *Hordeum jubatum* L., and *Sporobolus Texanus* Vasey. In the next zone *Aster multiflorus* Ait. and *Ambrosia psilostachya* DC. are added.

In the south end of the marsh, where there seemed to be much overflow deposit, although the greater part was still quite salty, the following plants were found: *Helianthus annuus* L., *Ambrosia psilostachya* DC., *Euphorbia marginata* Pursh., *Polygonum ramosissimum* Michx., *Iva ciliata* Willd., *Suæda diffusa* Watson, *Ambrosia trifida* L., *Polygonum Persicaria* L., and *Datura Stramonium* L.

Euphorbia marginata Pursh, *Datura Stramonium* L., and *Chenopodium hybridum* L. were found as perfectly isolated plants in the barren portion.

In the outer part of the marsh much the same vegetation is present as in the Big marsh. *Solidago Canadensis* L., *Iva ciliata* Willd., *Ambrosia psilostachya* DC., *Helianthus annuus* L., *Atriplex expansa* Watson, *Hordeum jubatum* L., *Sporobolus Texanus* Vasey, and *Sporobolus heterolepis* Gray are the plants characteristic of the transition zone.

SUMMARY.

1. The salt marshes of northern Kansas are characterized by large areas absolutely destitute of vegetation; by the paucity of species around their margins; and by the entire absence of all woody plants.

2. The vegetation of the streams flowing through them consists of diatoms and the three sedges, *Scirpus pungens* Vahl., *S. campestris* Britton, and *S. lacustris* L.

3. The three characteristic plants in and about the barren portion are *Distichlis maritima* Raf., *Polygonum ramosissimum* Michx., and *Suæda diffusa* Watson, of which the Suæda is by far the least abundant.

4. The plants which may be regarded as successful invaders are the following: *Iva ciliata* Willd., *Sporobolus heterolepis* Gray, *Sporobolus Texanus* Vasey, *Atriplex expansa* Watson, *Aster multiflorus* Ait., *Ambrosia psilostachya* DC., and *Hordeum jubatum* L. *Sporobolus Texanus* Vasey has never been reported, I believe, beyond the southern part of Kansas. Its abundance in the northern tier of counties of Kansas extends its northern limit nearly two hundred miles.

5. Among the less successful invaders which are quite common are the following: *Panicum Crus-galli* L., *Panicum virgatum* L., *Euphorbia marginata* Pursh, *Euphorbia glyptosperma* Engel., *Chenopodium hybridum* L., *Polygonum Persicaria* L., *Polygonum Hydropiper* L., *Amarantus chlorostachys* Willd., *Datura Stramonium* L., *Solanum rostratum* Dunal, *Xanthium strumarium* L., *Helianthus annuus* L., *Œnothera biennis* L., *Gaura parviflora* Dougl., *Elymus Virginicus* L., and *Spartina cynosuroides* Willd.

COLUMBUS, OHIO.

SOME NEW AND OTHER NOTEWORTHY PLANTS OF THE NORTHWEST.

J. M. GREENMAN.

SPIRÆA DENSIFLORA Nutt. in Torr. and Gray Fl. 1:414.

S. betulæfolia Pall. var. *rosea* Gray, Proc. Am. Acad. 8:381. 1872.
S. lucida Dougl. var. *rosea* Greene, Pittonia 2:221, 1892.
S. arbuscula Greene, Erythea 3:63. 1895.

This showy alpine plant, which has recently attracted considerable attention, was originally collected and characterized as *Spiræa densiflora* by Nuttall, whose type specimen is preserved in the Gray Herbarium. The first publication of the above name, however, appears in Torr. & Gray's *Flora* 1:414, where the plant is briefly described as a roseate-flowered form of *S. betulæfolia*, and the name *S. densiflora* Nutt. MSS. cited as a synonym. In *Proc. Am. Acad* 8:381 Dr. Gray established a variety *rosea* of *S. betulæfolia* Pall., based upon Hall's no. 124, but this plant is exactly the same in every regard as Nuttall's *S. densiflora*, and in no respect more perfectly characterized. In 1892 Prof. Greene (*Pittonia* 2:221) transferred the variety to *S. lucida* Dougl., at the same time suggesting the probability of its being a distinct species, and later (*Erythea* 3:63) published the same as *S. arbuscula*. The examination of a considerable amount of material confirms Prof. Greene's view that this plant should have specific rank; and that it is quite distinct from *S. betulifolia* Pall. may be seen by a comparison with the excellent illustration of the latter species in Pall. *Fl. Ross.* 1:33. *pl. 16*, but there seems no reason for discarding Nuttall's name *S. densiflora*, which although briefly was intelligibly characterized in 1844. The possibility of *S. pyramidata* being the same as *S. densiflora* Nutt., as suggested by Prof. Greene in *Pittonia* 2:221, is quite out of the question. The two plants are very different in inflorescence, foliar characters, and color of the flowers.

A very excellent illustration of *S. densiflora* Nutt. may be found in *Gard. & For.* 10 : *fig. 53*. It may be said, however, that the leaves are somewhat variable as to the serration, being crenate-serrate to rather sharply serrate. To this species may be referred: CALIFORNIA, Brewer 1777, 1932, 2090; Bolander 131; Lemmon, from Sierra Co. (in 1874); Torrey 131; Hansen 235; J. D. Hooker and A. Gray, Hermits Valley: OREGON, Hall 125; Cusick 122, in part, as to small leaved, purple flowered, densely corymbose form: WASHINGTON, Henderson 245; E. C. Smith 354; O. D. Allen 57, 290; Piper 1993; WYOMING, Nelson 941: BRITISH COLUMBIA, mountain slopes in the Selkirk range, Macoun. Probably also extending northward to Alaska.

In the second century of Mr. O. D. Allen's distribution of Washington plants, no. 125 was distributed as *Pyrus sambucifolia* Cham. & Schlecht. It should be referred rather to *Pyrus occidentalis* Watson.

Polemonium bicolor.—A low cespitose perennial: the stems covered below by persistent attenuate sheaths, which remain behind as the remnants of the earlier leaves: flowering stems 6 to 18^{cm} high, glandular pubescent with a few long pilose hairs intermixed, 1–3-leaved: the basal leaves with somewhat dilated or clasping petioles; the leaflets 21 to 31 in number, obovate-rotund to oblanceolate, 4 to 6^{mm} long, 2 to 4^{mm} broad, glandular-pubescent with a strongly glandular-ciliate margin, more or less crowded or sometimes imbricated: inflorescence cymulose: peduncles 1^{cm} or less in length, glandular-pubescent: calyx 6 to 8^{mm} long, veiny, glandular-pubescent with long spreading pilose hairs intermixed; lobes oblong linear, obtuse, corolla with a deep yellow throat and a dark purple to whitish limb, narrowly funnelform, 12 to 16^{mm} long; tube slightly ampliated above, somewhat exceeding the calyx; the obovate lobes 5 to 7^{mm} long: stamens shorter than the corolla; filaments not appendaged at their pubescent bases: style slender, filiform, nearly as long as the corolla: capsule glabrous, 4^{mm} long, or about one-half as long as the more or less persistent calyx; seeds angular, 1.5 to 2^{mm} long.—Collected by O. D. Allen on Mt. Rainier, Washington, altitude 2460^{m}, August 8, 1897, no. 294.

To this species may be referred specimens collected by Suksdorf on Mt. Adams (Mt. Paddo), Washington, altitude 2150–2460^{m}, August 9, 1882, no.

79; Howell, Mt. Adams (in 1882); Henderson 2411, East Mt. Adams; E. C. Smith 780, Mt. Rainier, altitude 2770^{m}, August 1890; O. D. Allen 62, Mt. Rainier; Piper 2129, Mt. Rainier, altitude 2770^{m}, August 1895.

A species well marked by its cespitose habit and glandular character, and especially by the long narrowly funnelform corolla, quite distinct from *P. humile* Willd. var. *pulchellum* Gray, with which it has been confused. The most nearly related species is the *P. Richardsonii* Graham, *Bot. Mag. pl. 2800*. A part of the type material of the latter species is in the Gray Herbarium, and it is a plant with larger nearly glabrous leaflets and somewhat broader calyx-lobes and less tubular corolla.

POLEMONIUM VISCOSUM Nutt. var. **pilosum**.—Stems 6 to 10^{cm} high; the entire plant covered with a spreading pilose pubescence intermixed with short glandular viscid hairs: leaflets usually less crowded or imbricated than in the type of the species: the calyx-lobes somewhat variable, oblong-ovate to distinctly oblong, obtuse or rounded at the apex: corolla white or pale blue with a yellowish center, 1^{cm} or less long.—Collected by O. D. Allen in clefts of rocks on Goat mountain, Washington, altitude 1540^{m}, July 6, 1896, no. 261.

Somewhat intermediate between the above variety and the species proper are specimens from Lassen's Peak, California, collected by J. G. Lemmon in 1875 (nos. 20, 960), referred by Dr. Gray to *P. humile* Willd. var. *pulchellum* Gray. Mr. Lemmon's specimens have the spreading pilose pubescent character of the variety, but to a much less extent, particularly on the calyx. There is also in the Gray Herbarium a specimen from Lassen's Peak, collected by Mrs. Austin in 1879, likewise referred to *P. humile* Willd. var. *pulchellum* Gray, which corresponds very accurately to Nuttall's type of *P. viscosum*.

Veronica Allenii.—Perennial: stems 6 to 8^{cm} high, nearly glabrous below, pubescent above: the lower leaves much reduced, the upper sessile, thickish, oblong or oblong-ovate, 10 to 14^{mm} long, 4 to 9^{mm} broad, obtuse, glabrous or with a few scattered hairs on the midrib and margin: inflorescence in a terminal raceme, glandular-pubescent: peduncles 2 to 5^{mm} in length, often exceeding the herbaceous glandular bracts: calyx unequally 5-parted; divisions oblong or oblong-ovate, obtuse or rounded at the apex, covered on the outer surface and along the margin with long slender glandular hairs: corolla 6 to 7^{mm}

in diameter, white or white with a slightly purplish puberulent throat; the upper lobe sub-rhombic, conspicuously emarginate, the lateral lobes ovate or ovate-rhombic, somewhat larger than the lower lobe: stamens exserted: ovary closely covered above with short glandular hairs; style exserted, about 5^{mm} in length: fruit not seen.—Collected by O. D. Allen along Paradise river on Mt. Rainier, altitude 1700^{m}, August 20, 1897, no. 95*a*.

A species habitally like *V. Cusickii* Gray, but differing by the somewhat smaller flowers, the white corolla, and less exserted stamens and style.

Castilleia oreopola.—Simple or many stemmed from a perennial base: stems erect, 1.5 to 3^{dm} high, somewhat furrowed by the inconspicuous decurrence of the leaves, below glabrous or nearly so, covered above with a scattered spreading soft pubescence: leaves sessile, oblong-lanceolate, 2 to 4^{cm} long, 5 to 10^{mm} broad, with one or two pairs of divaricately spreading linear-attenuate lobes, 3-nerved, glabrous or the uppermost covered with a soft spreading pubescence especially on the nerves and margins; the lower leaves much reduced, usually entire: inflorescence terminating the stem in a short close subcapitate raceme, later becoming elongated: bracts 3-cleft to the middle, the lobes as well as the calyx of a "deep rose-purple:" calyx 18^{mm} long, about equally divided anteriorly and posteriorly for one-half its entire length; lobes oblong-linear, obtusish: corolla 2^{cm} long; the narrow exserted galea green on the back with thin subscarious deep rose-purple margins; lip included, rather deeply and subequally 3-lobed: mature capsule oblong, about 1^{cm} long, glabrous.—Collected by W. N. Suksdorf in damp ground, on Mt. Adams (Mt. Paddo), Washington, altitude 1840 to 2150^{m}, August and September, 1891, no. 2046, distributed as *Castilleia miniata* Dougl. var. *alpina* Suksdorf; O. D. Allen, Mt. Rainier, altitude 2150^{m}, July 20, 1892, no. 11; also by the same collector in open ground on Goat mountain, altitude 1540^{m}, July 12, 1895, no. 134, the latter distributed as *C. alpina* Greenman, n. sp.

On account of the previous use of the name *alpina* in this genus by Porter it seems advisable to publish the species under the above name in order to avoid further and unnecessary change. A species readily recognized by the deep purple or almost magenta color of the bracts and flowers, and distinguished from *C. parviflora* Bong., its nearest ally, by the larger flowers, longer calyx, usually 3-cleft leaves, narrower and 3-lobed instead of 5-lobed bracts.

For some time it has been evident that the many forms under *Castilleia pallida* of American authors have constituted an extremely composite group. The recent activity among collectors of the northwest has brought to hand a considerable amount of complete material. A study of the group in the light of more copious material and recently collected specimens has made it possible to separate out as distinct species or varieties certain so-called forms hitherto included under *C. pallida*.

Castilleia pallida HBK. Nov. Gen. & Spec. **2**: 331. 1817; Kunth, Syn. Pl. Æquin. **2**: 100. 1823; Gray, Syn. Fl. **2**: 297. *Bartsia pallida* L. Spec. **2**: 602 (Gmel. Fl. Siber. **3**: 201. *pl. 42*). —Perennial: stems 1.5 to 3^{dm} or more high, rather sparingly pubescent below, covered above, especially in the inflorescence, with long somewhat matted hairs: leaves lance-attenuate, mostly entire, the upper usually broader and more or less lobed, soft-puberulent on either surface: calyx about 2^{cm} long, cleft about equally before and behind, the lateral divisions again more or less 2-cleft; lobes linear-lanceolate, obtusish: corolla slightly exceeding the calyx; galea about 7^{mm} long, nearly or quite twice exceeding the rather prominently 3-lobed lip.—Originally collected in Siberia.

There is in the Gray Herbarium a specimen, from the Herbarium of the Academy of St. Petersburg, collected by Chamisso on the island of Chamisso. This plant has been taken as typical of the species.

CASTILLEIA PALLIDA HBK. var. **lutescens.**—Stems 3 to 5.5^{dm} high, somewhat stouter than the species, usually branched above: leaves linear-lanceolate to oblong-lanceolate, the lower entire, the upper often trifid or sometimes even with a second pair of lateral lobes, scabrous especially on the upper surface: lip

slightly shorter in proportion to the length of the galea than in the species proper.—Suksdorf 424, prairies, Spokane co., Washington, June 1884; C. V. Piper 1667, Pullman, Washington, June 26, 1893; Rev. H. H. Spaulding, Clear Water, Oregon; F. Lamson Scribner 197, near Jefferson City, Montana, June 27, 1883; Messrs. Sandberg, MacDougal, and Heller 450, Latah co., Idaho, June 20, 1892; Macoun 5, Sproat, B. C., June 24, 1890.

CASTILLEIA PALLIDA HBK. var. **camporum**.—Stems usually several rising from a perennial base, 1.5 to 4^{dm} high, more or less covered with a spreading pilose pubescence: leaves narrowly oblong-lanceolate, the lower mostly entire, the upper irregularly laciniately 3–7-lobed with rather narrow ascending lobes, pubescent upon either surface: inflorescence greenish yellow or tinged with red, later becoming much elongated: calyx 2 to 2.5^{cm} long; lateral divisions again shortly 2-lobed (rarely entire), obtuse or even rounded at the apex; lip one-half to two-thirds as long as the galea.—Suksdorf 423, low prairies, Spokane co., Washington, June 1884; Piper 2514, Powder river mountains, Oregon, August 1896: Cusick 840, Union co., Oregon, 1879, in the Gray Herbarium under "*Orthocarpus castilleioides;*" also a duplicate specimen under "C. pallida fere vera." A specimen from Henderson, Lincoln co., Washington, 1892, no. 2266, seems to have its affinity here, as does also an imperfect specimen from the Herb. Geol. and Nat. Hist. Survey of Canada, collected by McEvoy, along Meadow creek, B. C., June 24, 1890, no. 2. In the latter specimen, however, the calyx is unusually long, being fully 3^{cm} in length.

The above variety appears to be intermediate between the species proper and the var. *occidentalis*, having more divided leaves and more spreading pubescence than the species, but approaching the var. *occidentalis* as shown by specimens collected by Scribner in the Little Belt mountains, Montana, no. 198, and also specimens obtained by Aven Nelson at Dome lake, Wyoming, no. 2435.

Castilleia pallescens.

Orthocarpus pallescens Gray, Syn. Fl. **2** : 299.
O. Parryi Gray, Am. Nat. **8** : 214.

The examination of a considerable amount of material shows that this species, hitherto somewhat doubtfully referred to Orthocarpus, has its affinity rather with the genus Castilleia. Notwithstanding the rather prominent lower lip and the short, broad galea, yet the very slight saccate character of the lip, and the calyx cut about equally before and behind with the lateral lobes shortly 2-cleft at the apex, combined with the perennial habit, all indicate its relation to Castilleia, and to the *C. pallida* group. In addition to the characters already given the following supplementary description may be appended. Stems 1.5 to 3^{dm} high, usually several rising from a woody perennial base, simple or sparingly branched above, cinereous-puberulent often with spreading pilose hairs, especially below.

Nuttall's specimen from the Rocky mountains; Parry 218, Northwestern Wyoming Expedition, 1873; Cusick 93, Union, Oregon, 1875; Canby, near Blackfoot City, Montana, July 11, 1883, no. 261 in part (as to specimens distributed under *Orthocarpus pallescens* Gray, not as to specimen distributed as *O. pilosus* Watson); Macoun, Kamloops, B. C., June 13, 1889; here also may be referred as more pubescent forms, Henderson 2267, 2268, 2269, Washington; and a plant of Dr. Lyall's Oregon Boundary Collection of 1860 originally distributed as "*Castilleja pallida* var.?"

Castilleia Cusickii.—Stems several from a procumbent base, 4 to 4.5^{dm} high, simple or branched above, green or greenish purple, covered with a short spreading or slightly reflexed cinerous pubescence: leaves scattered, sessile, 3-nerved, hirtellous-puberulent upon either surface, the lower leaves linear to linear-lanceolate, acute, 2 to 3^{cm} long, about 3^{mm} wide, the upper somewhat larger, 3.5 to 4.5^{cm} long, 3 to 5^{mm} broad, and usually laciniately lobed with one or two pairs of slender divaricately spreading lobes on either side, the veins beneath prominent: racemes rather dense, 3 to 10^{cm} long, 1.5^{cm} or less broad; rhachis covered with a long flaccid sublanate pubescence: bracts about equaling or slightly exceeding the flowers, oblong, obtuse, or rounded at the apex, usually undivided and entire, strongly ciliate toward the base, distinctly 3-nerved, and rather strongly reticulate-veined, 23 to 28^{mm} long, about 7^{mm} broad: flowers 2

to 2.5^{cm} long: calyx pubescent on the outer surface, nearly equally divided anteriorly and posteriorly; the lateral divisions linear-oblong, 2-dentate or shallowly 2-lobed at the apex, prominently 2-veined even to the base of the calyx: corolla 2 to 2.5^{cm} long, slightly exceeding the calyx, but scarcely twice the length of the rather prominent but not saccate 3-lobed lip: only the two anterior stamens protruding beyond the lip: style somewhat exceeding the galea, shallowly 2-lobed: capsule oblong, about 1^{cm} long, 4^{mm} broad, glabrous.—Collected by William C. Cusick in Sumter valley, Blue mountains, Oregon, July 6, 1897, no. 1700. The flowers are said by the collector to be "pale yellow rarely tinged with red."

A species related to *C. pallida* HBK., from which it is distinguished by the foliar characters, pubescence of the stem and leaves, and the long, slender inflorescence.

Castilleia levisecta.—Many stemmed from a perennial base: stems 1.5 to 3^{dm} high, usually unbranched above, covered with a soft more or less spreading unequal pilose pubescence: leaves oblong-lanceolate, 2.5 to 4^{cm} long, 5 to 12^{mm} broad, 3–5-nerved, pubescent upon either surface, often bearing rather long pilose hairs on the veins beneath: the lower somewhat narrower and often entire; the upper more dilated and shallowly lobed toward the apex with one to three pairs of lobes on either side: inflorescence rather densely spicate or subracemose: bracts yellow, rather broad, subdigitately lobed at the apex: calyx 15 to 18^{mm} long, nearly equally cut before and behind, externally pubescent; the lateral lobes again rather deeply 2-lobed, obtuse or rounded at the apex: corolla 2^{cm} or more long; galea 6 to 9^{mm} long; the lip one-third as long as the galea, shortly and obtusely 3-lobed: capsule glabrous, 8 to 10^{cm} long, usually covered by the persistent pubescent calyx.—Howell 279, Mill plain, Washington, 1880, O. D. Allen 83, Roy, Washington, May 19, 1889; F. Binns, in open woods and hills, Pt. Ludlow, Washington, June 15, 1890; Macoun 715, vicinity of Victoria, Vancouver Island, B. C., May 16, 1893.

A species hitherto confused with *C. pallida* HBK., but differing materially in the foliage, and in the character of the lip of the corolla.

Castilleia cervina.—Cinereous-puberulent throughout: stems simple, 6^{dm} or more high, somewhat striate above: leaves usually deeply 3(–5)-parted, with the lateral divisions linear-attenuate and divaricately spreading: the lower flowers of the spicate inflorescence short-pedicellate: bracts laciniately 3–5-lobed, lobes ascending, these as well as the calyx and corolla, in the dried state, tipped with yellow: calyx 1.5 to 2^{cm} long, more deeply cut before than behind; the lateral lobes again shortly and acutely bilobed: corolla 2 to 2.5^{cm} long; galea about 6^{mm} long; the lip nearly or quite one-half as long as the galea, lobes conspicuous and subequal: stamens and stigma exserted.—Collected by Dawson on dry ground, Lower Arrow lake, B. C., June 17, 1889; and in the same locality by Macoun, June 5, 1890, no. 11.

Most nearly related to *C. brevifiora* Gray, from which it is readily distinguished by the taller habit and the pubescence of the inflorescence.

NEMACLADUS RIGIDUS Curran. This interesting little plant, hitherto known only from the type locality, was collected by Mr. Cusick on the hillsides of the Malheur, Oregon, June 1897, no. 1625.

GRAY HERBARIUM OF HARVARD UNIVERSITY.

BRIEFER ARTICLES.

NOTES ON CAREX. XIX.

Carex Madrensis, n. sp.— One of the INDICÆ, and, with *C. Schiedeana* Kunze, making a well-marked section of that group: slender, a foot to eighteen inches high, with short and flattish leaves: spikes about four, aggregated, or the lowest one or two remote and long-peduncled from sheaths, a half inch long, and ovate or nearly globular, the apical staminate part very short: perigynium obovoid and slightly excurved, distinctly and abruptly beaked, the orifice slightly toothed, the body trigonous and strongly few-nerved, somewhat scarious, but not hairy or pubescent: scale broad and blunt, with a short cusp, brown, with a dorsal nerve, shorter than the light-colored perigynium.

Differs from *C. Schiedeana*, its nearest relative, in its much laxer habit and softer leaves, the absence of long bracts subtending the upper spikes, the more scattered spikes, the long peduncles of the lower spikes, the glabrous less-nerved perigynium, and the broader and blunter scales.— Near the top of the Sierra Madre mountains, State of Durango, Mexico, *J. N. Rose* 2357. 1897.

Carex Seatoniana, n. sp.—Allied to *C. spissa* Bailey, but less stout, spikes loosely flowered, perigynia ascending and thinly haired or hispid: plant five or six feet high, with stiff, rough-edged, light-colored leaves: spikes about ten, half of them pistillate, with short staminate tips, the lower ones long-stalked and five or six inches long, narrow and loosely flowered: perigynium ovate to obovate or almost turbinate, firm and not inflated, strongly few-nerved, short-beaked, with the orifice entire or nearly so, sparsely hispidulose, often puncticulate: scales awl-like and serrate, or becoming broad and merely cuspidate near the apex of the spike.

A well-marked plant, with scattering perigynia in the midst of the long spikes, and more densely flowered near the apices, all the scales below the tips very long and prominent.— Moist river bluffs, near Tula, Mexico, *Pringle* 7452. 1897. Dedicated to the memory of Henry E. Seaton, late assistant curator of the Gray Herbarium and student of Mexican plants.

Carex galbana, n. sp.—Related to *C. triceps* Michx.: a weak plant, with slender curving culms a few inches to a foot long, much overtopping the short flattish leaves: spikes two or three, small (half inch or less long), aggregate, staminate below, the bracts not prominent or leafy: perigynium trigonous-turbinate, greenish and glabrous, strongly few-nerved, the beak scarcely any, and orifice entire: scale thin and brownish, blunt, narrower and shorter than the perigynium.

Differs from *C. triceps* and its varieties in its very different habit, glabrous foliage (leaves very sparsely ciliate on the edges near the base), and the absence of leafy bracts.—Sierra de las Cruces, 10,000 feet, State of Mexico, *Pringle* 7083. 1896.

Carex irrasa, n. sp.—(*C. Douglasii* Boott var.? *laxiflora* Bailey, Mem. Torr. Bot. Club 1: 20.)

Aside from the original specimens collected by Williams near Utica, Montana, I now have the plant from Big Lost river, Idaho (*Henderson* 3698). It seems to have little in common with *C. Douglasii*, to which I provisionally referred it, being distinguished by its open brown simpler head and looser-flowered spikes, taller and more slender habit, often rough-angled perigynium, and shorter styles.

Carex turgidula, n. sp.—Allied to *C. acutina* Bailey and *C. stricta* Lam. var. *decora* Bailey, but distinguished from all members of this group by its thin and turgid perigynia and spreading-pointed black scales: erect and stout, 12 to 18 inches high, the culms overtopping the flat bright green leaves: pistillate spikes one to three, approximate near the top of the culm, varying from a half inch to an inch and a half long, the lowest one or two very short-stalked and subtended by rather short leaf-like bracts, most of them with a staminate apex: perigynium small and globular or turbinate, very abruptly contracted in a very short entire beak, nerveless except on the angles, turgid or inflated, shorter than the black-brown pointed spreading scale.

Stewart's Lake, British Columbia (*Macoun*); near Portland, Oregon (*Henderson*); Lake Waha, Nez Perces county, Idaho (*Heller* 3400).

Carex Oaxacana.—I propose this name for the *C. olivacea* of Liebmann. Mr. Pringle collected the plant at an altitude of 9000 to 10,000 feet, on the Sierra de San Felipe, Oaxaca (no. 4842) in 1894. It is a well-marked species, allied to *C. virescens* Muhl., but with narrow-trigonous and distinctly beaked glabrous perigynia and stiffish sparsely hairy herbage. The synonymy of this much named plant is as follows:

C. olivacea Liebm. Mex. Halv. 79 (1850), not Boott (1846).

C. monticola Boeckl. Engler's Bot. Jahrb. 1 : 364 (1881), not Dewey 1861).

C. androgyna Bailey, Proc. Amer. Acad. 22 : 101 (1886), not Balbis.

Liebmann reports it from the Peak of Orizaba.

CAREX OBLATA Bailey, var. **luzuliformis,** n. var.— Differs from the species in being much taller (two feet or more), with broader leaves and much larger spikes.

Idaho, Oregon, California. It is 6210 of the California Geological Survey and 1426 of the Department of Agriculture Death Valley Expedition (*Coville & Funston*). In some cases I have confounded this with *C. luzulæfolia* W. Boott, but that species differs in its broader foliage, and particularly in its broader, papery, and more turgid perigynia. The perigynia of *C. oblata* and var. *luzuliformis* are long and gradually tapering, hard and not at all inflated.

L. H. BAILEY, *Cornell University*.

THE SYSTEMATIC POSITION OF THE GENUS MONOCLEA.

THE genus Monoclea, according to Schiffner,[1] contains one certainly known species, *M. Forsteri* Hook., and a second one, *M. dilatata* Leitgeb, which Schiffner thinks should probably be united with *M. Forsteri*. The American form of the latter has been separated as *M. Gottschei* by Lindberg, but is not usually considered to be distinct.

Monoclea Forsteri is apparently common throughout tropical America, and during a visit to Jamaica in the summer of 1897 I met with the plant repeatedly in the wet mountain ravines, and upon the dripping rocks along the margins of streams. In such situations the plant occurred in large masses and was very conspicuous.

Hooker's original description[2] I have not seen, but from the reference to this in Gottsche's paper,[3] it must be very incomplete, as there was an evident confusion of the plant with Anthoceros and Dendroceros. The locality from which the original plant came seems also to be doubtful.

The first account of the plant which is at all complete is that given

[1] ENGLER and PRANTL, Die natürlichen Pflanzenfamilien 91–92 : 56.

[2] HOOKER, Musci exotici. London, 1820.

[3] GOTTSCHE, Ueber das Genus Monoclea. Bot. Zeit. 19 : 281–289. 1858.

by Gottsche in the paper already referred to. Leitgeb[4] in his great work upon the Hepaticæ made some additions to Gottsche's description and corrected his error as to the origin of the archegonia. Both of these observers studied the female plant only, but in the last part of this work,[5] Leitgeb describes the male plant of what he considered a distinct species, to which he gave the name *M. dilatata*. The specimens came from New Zealand and were supposed to be a species of Dumortiera, which Monoclea resembles very closely in general habit.

Finally Ruge[6] has added materially to our knowledge of the plant, especially as regards the development of the reproductive organs.

While Gottsche and Leitgeb both recognized the obvious resemblance of the thallus of Monoclea to that of Dumortiera, they concluded that the complete absence of the characteristic lacunae of the marchantiaceous thallus in the former forbade its being placed in the Marchantiaceæ, and that its nearest affinity was with the thallose Jungermanniaceæ like Pellia and Pallavicinia.

A careful examination of the material collected by me last summer, as well as a study of the observations made by Leitgeb and Ruge, have convinced me that the genus should be removed from the Jungermanniaceæ to the Marchantiaceæ with which it much more closely agrees. The form of the thallus and the character of the apical cell were recognized by Leitgeb as marchantiaceous, but as the air-chambers were quite absent he concluded that this resemblance was purely superficial. While admitting the absence of lacunae in some forms of Dumortiera, he claimed that these were always formed in the youngest part of the thallus and were destroyed later. However, a careful examination by the writer[7] of *D. trichocephala* showed that in this species these were completely absent from the beginning, and the structure of the thallus corresponded in every respect with that of Monoclea. The most marked difference between the latter and the other Marchantiaceæ is the absence of the ventral scales, which are here represented only by papillate hairs of very brief duration. These, however, correspond in origin with the scales of the ordinary types, and simply remain undeveloped.

Monoclea, unlike any of the Jungermanniaceæ, has two sorts of root-hairs, thin-walled ones like those of the latter, and thick-walled

[4] LEITGEB, Untersuchungen über die Lebermoose 3 : 62. [5] Op. cit. 6 : 131.

[6] RUGE, G., Beiträge zur Kenntniss der Vegetationsorgane der Lebermoose, Flora **77** : 279. 1893.

[7] CAMPBELL, D. H., Mosses and Ferns 49. 1895.

rhizoids which are doubtless the homologues of the characteristic tuberculate ones of the typical Marchantiaceæ.

It is the structure and arrangement of the sexual organs, however, which prove the close affinity of Monoclea with the Marchantiaceæ. Both Leitgeb and Ruge noticed the extraordinary resemblance of the male receptacle to that of such forms as Conocephalus or Fimbriaria, and Ruge's figures show that the development of the antheridium is thoroughly typical of the Marchantiaceæ, although he makes no mention of this fact in the text.

The origin of the archegonia is exactly as in Targionia, and I have found that there are six rows of neck-cells, as in the Marchantiaceæ, instead of the five regularly found in the typical Jungermanniaceæ.

It seems strange that Ruge did not recognize the obvious marchantiaceous character of the reproductive organs, but he passes over this point without comment. Schiffner[8] places the genus in the Jungermanniaceæ, near Pallavicinia and Symphyogyna, although admitting marked differences in the character of the sporogonium.

In regard to the exact position of Monoclea, it will not be possible to decide until more is known of the development of the embryo. At present it seems to approach Targionia more nearly than any other genus. The resemblance to Dumortiera is probably purely superficial, and simply indicates a similar adaptation to similar semi-aquatic environment.

We may safely conclude that the affinities of Monoclea are with the lower series of Marchantiaceæ, perhaps the Targionieæ, where the archegonia are borne directly upon the unmodified thallus, and no definite receptacle is developed. The absence of lacunae, as well as the simplification of the rhizoids and ventral scales, are with little question secondary, as they are in Dumortiera, where, however, the reduction is not quite so marked; and these reductions are correlated with the almost aquatic nature of these plants. There is little reason to suppose that the two genera are closely related, as Dumortiera shows undoubted relationship with the higher Marchantieæ, like Marchantia, where both antheridia and archegonia are borne upon specially modified receptacles which are compound, representing a branch-system. Monoclea may be supposed to bear the same relation to the lower Marchantiaceæ that Dumortiera does to the higher ones.—Douglas Houghton Campbell, *Stanford University*.

[8] Engler and Prantl, loc. cit.

THE ROCKY MOUNTAIN SPECIES OF THERMOPSIS.

(WITH PLATE XVIII)

THE difficulty of fitting all my specimens to the accepted descriptions of the heretofore published species of Thermopsis long since led me to suspect that more than two species were represented in this region. Of this I became convinced when perfectly typical material of *Thermopsis montana* Nutt. was secured in the western part of the state in 1897. The plant, common on the streams near Laramie, which I had long supposed to be that, and of which I had not heretofore secured fruits, turned out, as the fruits show, to be a very different one.

A closer examination of the characters of *T. rhombifolia* Rich. reveals also that some of the specimens that I had unwillingly placed under this name are, instead, a good species. *T. rhombifolia* differs from this in its habitat, mode of branching, its inflorescence, and other characters pointed out in the description. In looking over the recent description of *T. rhombifolia* in Britton and Brown's *Flora* it seemed to me probable that the measurements given, especially of the leaves, were hardly great enough.

The species of this region, as they now appear to be, are *T. montana*, *T. rhombifolia*, and the two proposed species. The fruits of these are very characteristic, a fact shown in the accompanying plate. The four fruiting racemes are all from Wyoming material, are mature and typical each of its species. They were photographed on one plate, hence the size is relatively correct (about one-third natural size).

Thermopsis divaricarpa, n. sp.— Erect, 5–8^{dm} high: stems several from the perennial root, youngest slightly pubescent especially upwards, nearly simple, bearing only two or three slender sterile branches from the upper axils, one or two of these generally overtopping the matured raceme: leaves large; leaflets sparsely appressed pubescent beneath, rhomboid or narrowly elliptic to oblanceolate, from acute to rounded obtuse, 5–10^{cm} long, 1.5–3.5^{cm} wide, nearly sessile; petioles 2–3^{cm} long; stipules large, ovate or the uppermost on the sterile branches narrower, somewhat inequilateral, longer than the petioles (3–5^{cm}): raceme strictly terminal on the main axis, rather dense: flowers large, yellow, about twenty; pedicels stout, 1^{cm} long, longer in fruit: calyx large, lobes shorter than the tube, the sinus

between the two united upper lobes shallow: pods large, linear, 8–10^{cm} long, about 7^{mm} wide, finely pubescent when young, obscurely so when mature, from nearly straight and erect when young to divaricate and slightly curved when mature, 10–15 seeded.

It is found near streams, preferring the moist, rich soil among the open underbrush. Type specimens in Herb. Univ. of Wyo., no. 3424 by Elias Nelson, Pole creek, July 22, 1897; and no. 3903 by the writer, Johnson's ranch, Big Laramie river, August 8, 1897.

Thermopsis arenosa, n. sp.—Smaller in every way: stems from the persistent branched bases more numerous, branching and habit similar, 3–4^{dm} high: leaflets proportionately wider, from oblong or oblanceolate to obovate, 3–4^{cm} long, 1–2.5^{cm} wide; stipules longer than the petioles, broad, from ovate to suborbicular: fruiting racemes shorter: pods inclined to be divaricate from the first, shorter, at maturity constricted between the fewer large seeds.

These two species are very different in seasonal development and habitat. This last is very abundant in the Laramie hills in dry, open, sandy, or stony draws and ravines. Heretofore confused with *T. rhombifolia* from which it differs in its larger leaflets, longer stipules, its strictly terminal raceme and its curved, divergent, loment-like pod.

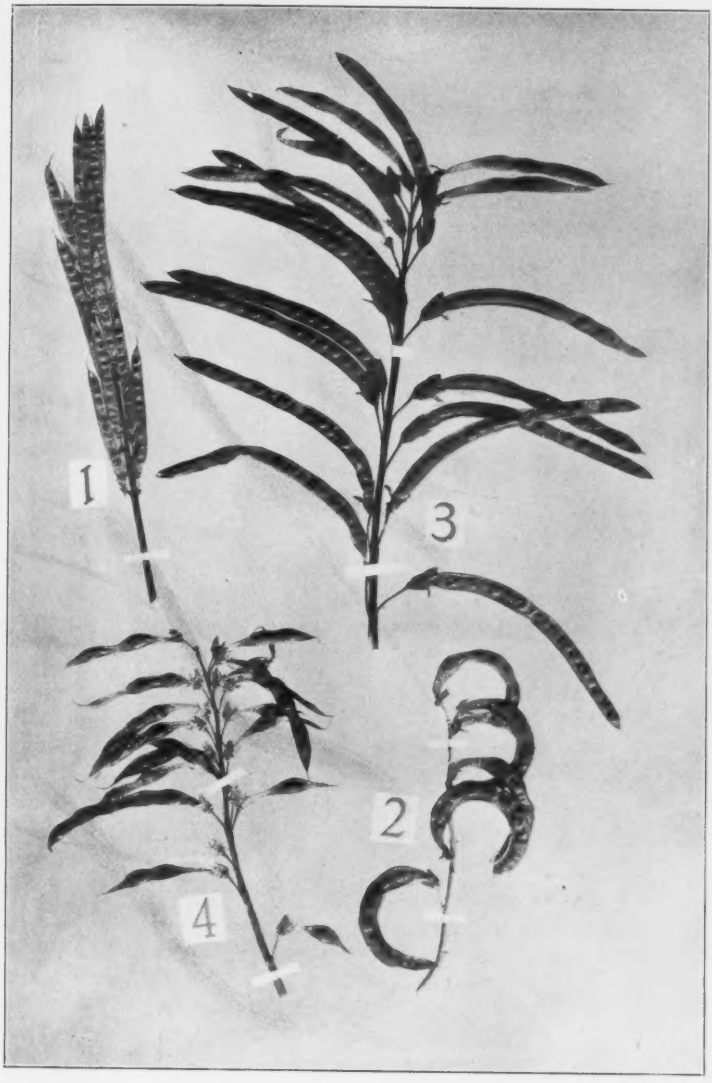
Type specimen in Herb. Univ. of Wyo., no. 3182, Laramie hills, June 16, 1897; fruit from the same locality July 17, 1897. Others nos. 122 and 1240.—AVEN NELSON, *The University of Wyoming.*

EXPLANATION OF PLATE XVIII.

FIG. 1. *Thermopsis montana* Nutt. FIG. 2. *T. rhombifolia* Rich. FIG. 3. *T. divaricarpa* Aven N. FIG. 4. *T. arenosa* Aven N.

NOTES ON THE BOTANY OF THE SOUTHEASTERN STATES. I.

HAVING the opportunity to study a considerable collection of plants gathered mainly during the past few years at various stations in the southeastern United States, I have decided to publish at intervals the results of the investigation so far as they relate to species that appear to be either undescribed, unrecorded in the recognized flora of the region, or of too restricted geographical range as indicated in recent literature on the subject. In the present paper one species is proposed



NELSON on THERMOPSIS.

as new, one is raised to specific standing, two suppressed species are restored, and the heretofore recorded range of others greatly extended.

PHILADELPHUS LATIFOLIUS Schrad. DC. Prodr. **3**: 206. 1828.—An ignored and much confused species closely related to the European *P. coronarius* L. Abundant material in fruit collected on the rocky banks of the Cumberland river near Nashville, Tennessee, August 17, 1897, so clearly illustrates the validity of the species that I concur with Engler[9] in his statements regarding it, especially as to its frequent occurrence in cultivation and the confusion of American botanists. However, I know no other habitat than middle Tennessee. Torrey and Gray[10] referred all of Schrader's species published in the Prodromus[11] to *P. grandiflorus* Willd., or to forms of the same, a position not wholly sustained by recent writers, and their variety *floribundus* is truly the species at issue.

Philadelphus latifolius differs from *P. grandiflorus* in bearing flowers in naked racemes (sometimes a lower pair axillary) 5–9 but mostly 7-flowered, by the much smaller capsules; narrower, more pubescent calyx lobes; the 5-nerved leaves, which on young shoots are large and broadly ovate; and by the light colored bark. I have seen a flowering specimen of this fine species in the Philadelphus material of the National Museum, collected by Dr. Gattinger in 1888 from the same locality and distributed by A. H. Curtiss as *P. hirsutus* Nutt., where it is associated with fruit of the last named species. It is very common on the limestone bluffs of the Cumberland river in middle Tennessee, and its distribution will doubtless be found to cover a much wider area when the species is better known.

RUDBECKIA PINNATILOBA (Torrey & Gray).

R. triloba pinnatiloba Torr. & Gray, Fl. **2**: 309. 1841–1843.

Heretofore known only from the state of Florida, where it was collected and distributed by Dr. Chapman. On August 2, 1897, quantities of the same distinct plants were found on the dry slopes of Cedar Cliff mountain, Buncombe county, North Carolina, that match the Florida material as represented by the Chapman specimens at Biltmore, and, according to Dr. Small, similar material at Columbia University. From a study of the material, which embraces a large

[9] Die natürlichen Pflanzenfamilien III. **2a**: 71. 1891.

[10] Flora N. Am. **1**: 595. 1838–1840.

[11] DC. Prodr. **3**: 205–206. 1828.

range of specimens, I am persuaded the plants should be regarded in full standing. The only other name that has been applied to the species, it seems, is *R. biennis* Chapm. in MSS., as cited by Torrey & Gray. *Rudbeckia pinnatiloba* not only differs from *R. triloba* in the form of the leaves, but by its lesser size, more pubescent stem, smaller heads and earlier time of flowering.

JUNCUS TRIFIDUS L. Spec. Pl. 326. 1753.—From the published statements regarding the range of this species it would seem that no authentic stations south of New York have been recorded. On July 8, 1897, and several days later, *Juncus trifidus* was found in abundance growing from the crevices of the rocks on the summit of Craggy mountain (2000^{m} elevation), Buncombe county, North Carolina.

Polymnia lævigata, n. sp.—Perennial herb, 0.5 to 1^{m} high, slender, branching: leaves thin-membranaceous, the upper deltoid-ovate with edges irregularly lacinate-dentate and the apex long acuminate; the lower broadly oval in outline, pinnately 5–7-lobed, the divisions acuminate; the upper surface along the veins puberulent, below minutely resinous atomiferous; upper surface of the petioles and a broad line along the stem and branches more or less purple and puberulent, especially at the nodes: heads loosely paniculate, nodding, light yellow: rays 3–5: ligule 3-lobed and almost white: achenes sparingly puberulent to glabrous, 5-costate and with an elevated epigynous disk at the summit: disk flowers campanulate, abruptly contracted into a long narrow tube, the lobes fimbriate and acute: the outer scales obovate, the inner oblanceolate, more or less fringed.

A most remarkable and distinct species collected at Cowan, Tennessee, August 21, 1897, and finding its nearest relative in *P. Canadensis radiata* Gray, from which it may be separated by the long acuminate lobes of the leaves, the 5-costate achenes, smaller size and almost glabrous stems and leaves.

VIOLA TENELLA Muhl. Cat. 26. 1813.—I cannot feel that there is any doubt about this species being truly indigenous. In rich, but shallow soil, on the rocky summit of Cedar Cliff mountain (1130^{m} elevation), Buncombe county, North Carolina, *Viola tenella* was found in flower, April 9, and again May 11, 1897, in fruit. In this situation, where there is but the remotest possibility of adulteration of the flora, the species is most abundantly represented. An interesting

note in this connection is preserved in the Chapman Herbarium, where it is associated with material collected in the cedar barrens of Tennessee, and written by Dr. Gattinger, as follows: "Can impossibly be an introduced plant! Is one of the characteristic spring plants of the cedar barrens."

AMORPHA GLABRA Desf. Cat. h. Par. 192. 1804.—Much uncertainty regarding the genus Amorpha as represented in the south Atlantic states is plainly displayed by writers, and with a view to clearing away some of this uncertainty I propose the restoration of a neglected species. Torrey & Gray[12] give a description of *A. Caroliniana* Croom (*A. cynostachya* Curtis), a name they replace on page 690 of the same work by *A. glabra* Desf., and it is remarkable that this plant should in later times be associated with *A. fruticosa* L.[13] I have not at hand the original description of Desfontaines, and that in the Prodromus[14] is at best poorly applicable to Croom's *A. Caroliniana*, but on the evidence of Torrey & Gray, as above cited, I adopt the name and append a more tenable description.

A suffrutescent perennial, 1–1.5^{m} high, nearly glabrous. Stems several, slender, erect or ascending and leafy throughout, purplish and more or less verrucose: leaves 1.5–2^{dm} long, 3–4^{cm} wide: leaflets 12–20 pairs, oblong or elliptical, petiolulate, stipellate, punctate and apiculate by the excurrent midrib: spikes 1.5–2^{dm} long, panicled, densely flowered: calyx glandular, more or less villous on the margins of the unequal or dissimilar teeth, short pedicelled and the tube furrowed: vexillum violet blue: style hairy: pod one-seeded, 4–5^{mm} long, 2^{mm} broad, glandular roughened, the dorsal suture straight.—Low, sandy pine barrens from North Carolina to Florida as shown by specimens in the Biltmore Herbarium.

A. glabra may be distinguished from *A. herbacea* Walt., to which it is very closely related, by its smoothness, more slender habit, and bright colored flowers; from *A. virgata* Small by the diminutive legumes, smaller and twice as numerous leaflets; and from *A. fruticosa* by the straight dorsal suture of the small, one-seeded pods. I have observed no intermediate forms that would warrant the consideration of *A. glabra* as a variety of *A. herbacea*.

STYLOSANTHES RIPARIA Kearney, Bull. Torr. Bot. Club **24**: 565. 1897. — Specimens that agree substantially with the characters assigned to

[12] Flora N. Am. **1**: 305. 1838–1840.
[13] SERENO WATSON, Bibliog. Index 188. 1878.
[14] DC. Prodr. **2**: 256. 1825.

this species have been collected in Florida by Dr. Chapman, in Delaware by Mr. Canby, and in eastern North Carolina by the Biltmore Herbarium. All of the material, except possibly that from Delaware, compares favorably with Mr. Kearney's specimens collected in Cocke county, Tennessee, in habit, lobing of the vexillum and peculiarities of loment. In the plants from Delaware the vexillum is not constantly lobed, differing in this respect, indeed, on the same individual. —C. D. BEADLE, *Biltmore Herbarium.*

THE GUM OF CANNA.

WHEN a freshly cut tuber of Canna is exposed to the air, there may be observed upon the cut surface, after some hours, the formation of small colorless or pale yellow drops, which stiffen rapidly in the air. From these there finally develop spherical masses of no mean size. Their color varies from very pale yellow to brown or bottle-green. If fractured they show a glistening and conchoidal appearance. This substance has the character of a gum. It is insoluble in water, even after long boiling, and it swells up in precisely the same way as do the gums of the cherry and apple.

When heated upon a platinum knife this gum of Canna swells up, chars, and then burns with a smoky flame, leaving considerable very white and light ash. This ash contains calcium carbonate, magnesium, iron, potassium, and phosphoric and hydrochloric acids.

For the study of the method of the formation of this gum, it was found convenient to use rootstocks which had first been macerated in strong alcohol. Sections were examined, either at once upon being made, or after having been subjected to a double stain produced by successive immersions in a hydro-alcoholic solution of red extract of Cassella, and a similar solution of acid green JEEE (Poirrier).[15] The washings were made in water containing alcohol, and the sections mounted in carefully prepared neutral glycerine.

Staining with haematoxylin gave poor results, probably on account of the resistance offered to its diffusion by the insolubility of the gum.

Upon first examination of the preparations one is tempted to assign

[15] I prepared these solutions according to the following formulæ:

Rouge de Cassella	0.25gm	Acid green JEEE (Poirrier)	0.10gm
Alcohol at 90%	20.00gm	Alcohol at 90%	20.00gm
Distilled water	30.00gm	Distilled water	30.00gm

to the gum-bearing tissue of Canna a schizogenous origin. It certainly presents an aspect very suggestive of gum secreting cavities.

The fact is, however, that very little of the gum makes its first appearance upon the cell walls. It forms in thick layers in the cell interior, and, gradually condensing, forces the cytoplasm and its contents into the center. Little by little this alteration extends into neighboring cells. The condensation of the protoplasm is constantly increased in the central cells, whose walls seem to thicken as the membrane increases in volume. At a certain point the protoplasm and the thickened membrane surrounding it blend into a mucilaginous mass. This transformation may appear at first either in a single cell, or in a little group of cells always placed near the center of the mass. In no case did I notice any such intercellular space surrounding the secreting cells as occurs in the ordinary method of formation of secreting canals. The gum of Canna is formed in a lysigenous way, just as are those of the acacias, of fruit trees, and especially of the aralias. As gelatinization continues the gum-bearing region spreads, and tends to form pockets of varying form and dimension.

Formations of the same kind may occur in the fibrovascular bundles. Gelatinization is produced first in the wood and woody parenchyma. The gum then penetrates into the vessels, probably by osmosis; the walls of the vessels become gelatinized in their turn, and the whole bundle is transformed into a gum bearing cavity.

There should also be noted the extreme diminution of amidon in the neighborhood, which immediately succeeds the mucilaginous modification.

I have studied the same point in a large number of stems of other Marantaceæ taken from dried specimens in the Museum d'Histoire Naturelle, and from the Ecole supérieur de Pharmacie de Paris. In none have I found an analogous formation. — M. L. Lutz, *Paris, France.*

CURRENT LITERATURE.

BOOK REVIEWS.

An elementary botany.

THE TASK of writing an elementary text-book that shall be satisfactory from the pedagogical as well as the scientific point of view is not an easy one, and the result is at best but a compromise in which the instructional necessities should predominate in the selection of material for presentation.

With these facts at hand it must be acknowledged that it is well-nigh hopeless to attempt to produce a manual which shall meet the conditions existing in any great number of schools. The last few years have seen the appearance of many such books in America, which met with no favor outside of the sphere of the personal influence of the author.

The recent effort by Mr. Groom[1] deserves attention. The book is written for students not furnished with compound microscopes and attendant facilities, which are both needless and harmful to young beginners. The author is examiner in botany to Oxford University, and has presumably selected the material for his book with reference to the requirements of English schools. The contents include general morphology, classification of the angiosperms, and physiology.

About one hundred pages are devoted to the segmentation and development of the root and shoot, together with the mechanism of reproduction. A large proportion of this space is devoted to definitions of morphological areas, in which it is scarcely necessary to say that accuracy and conciseness are well shown. The subjects of pollination, fertilization, and seed dispersal are more sensibly treated here than in any elementary text which has yet appeared. Omission of consideration of lower forms is, of course, to be taken for granted.

Under classification, descriptions of thirty important or common families are given.

The section of forty pages devoted to physiology has been so written that no knowledge of histology is assumed, an innovation which will be much appreciated by instructors, and which might well be taken into account in the preparation of more advanced manuals. The principles of physiology are

[1] GROOM, PERCY.—Elements of Botany. 16mo. pp. x + 252. *figs. 250.* London, New York: George Bell & Sons. 1898. 3*s.* 6*d.*

treated with a simple directness of statement that is much to be commended. Still further illumination is obtained by the outlines of easy demonstrations and experiments to accompany the context. The illustrations are clear and well selected throughout, and many of the best are original. The book will be found very useful in American as well as in English schools.—D. T. MACDOUGAL.

Cultivated plants of Asia Minor.[2]

IN A BOOK of 278 pages devoted to the natural resources of Asia Minor, Kannenberg has given something over one hundred pages to the cultivated plants of the region. The account is a contribution to agriculture and current history rather than to botany, but the student of cultivated plants will find it useful nevertheless, since it attempts to make an annotated inventory of all the leading plants cultivated or used for food, used in the industries, for ornament and the like, and also an account of forests and timbers. The botanical names of the various species are not given, and this detracts from the value of the book for specific reference, particularly in such confused groups as the rose and the cucurbits. Very full references are given to the literature of the various entries, and the reader will find much of interest in the discussions of local and geographical names for species and varieties. The book is essentially a compilation, the work of Hehn and others being laid under heavy tribute. There are many striking half tones. The book seems to be a distinctly good contribution to the popular knowledge of the immediately useful natural history of the region.— L. H. BAILEY.

The ferns of the earth.

Dr. H. Christ[3] has published a general systematic account of ferns which is intended for popular rather than for technical use. This group has always been an attractive one for general presentation, ever since the *Synopsis Filicum* of Swartz in 1806. The last general presentation was the *Synopsis Filicum* of Hooker and Baker, edition of 1883.

The author restricts himself in various ways, so that the work may not be too bulky, and still may be a good general presentation of ferns. He confines himself to the homosporous Filicineæ, with their leptosporangiate and eusporangiate groups. Moreover, he does not include doubtful species, or even doubtful genera, attempting to present only those genera and species which are well established and representative. Of course his work is intended

[2] KANNENBERG, KARL.—Kleinasiens Naturschätze, seine wichtigsten tiere, Kulturpflanzen und Mineralschätze. Berlin: Gebrüder Borntraeger. 1897. *M.* 14.

[3] CHRIST, H.—Die Farnkräuter der Erde. 8vo. pp. xi + 388. *figs. 292.* Jena: Gustav Fischer. 1897. *M.* 12.

merely for those interested in determining ferns, and it stops precisely at the point where interest for the specialist begins.

Another principle in the selection of species has been to include those which are remarkable in structure, phylogenetic character, or biological peculiarity. Those genera which, as he says, "are weakly expressed, showing only one or a few disappearing species," he omits in favor of those which are rich in species and uniform in character. He also omits peculiar island types, such as those of the Sandwich islands, Madagascar, etc.; nor does he include the rich fern flora of the Andes. His contention is that a comprehensive monograph, with a critical catalogue of all species, would be a work of several volumes, and would not serve the general purpose he has in view. With all these restrictions he presents 99 genera and 1154 species.

No analytic keys are provided, but simple descriptions of genera, sections, and species are depended upon to guide sufficiently. The author claims that a safe key is only possible for a limited flora and small genera, and that the more inclusive the key the more unsafe does it become. The descriptions are exceedingly simple, technical terminology being avoided so far as possible.

An excellent feature of the book is to be found in the numerous illustrations in the text accompanying the descriptions. These illustrations show at a glance the characters described by the text. It would be a useful thing if American students of ferns had a translation of this handy and simple volume.—J. M. C.

Text-book of lichenology.[4]

IT IS so long since any work on lichens has been published by an American author that we take up Dr. Schneider's book with especial interest. In the preface we find this statement: "This work is primarily intended as a text-book for the use of students in colleges and universities, but will also be found useful to the specialist." Our secretly cherished hope that the study of lichens is to be popularized begins to fade away when we read that statement. As we glance over the technical treatment outlined for the subject, the hope entirely disappears. The book will be useful to those for whom it was written, but a feeling of regret will arise that it was not adapted for more general use. The plates, of which there are seventy-eight, add greatly to the value of the book, though it must be said that they are somewhat schematic. The subject-matter is divided into two parts. Part I treats of the history, general morphology and physiology of lichens; Part II of the classification and special morphology of lichens.

The first subject treated is the history of lichenology. This is stated to

[4] SCHNEIDER, ALBERT.—A text-book of general lichenology. Large 8vo., pp. 230, 76 plates. Binghamton, N. Y.: Willard N. Clute & Company. 1897.

be in the main "a condensed retrospect of Krempelhuber's *Geschichte der Lichenologie*," Krempelhuber's book bearing the date of March 1886. Dr. Schneider adds two periods to bring the history up to date: one from Schwendener (1886) to Reinke (1894), the other from Reinke (1894) to the close of 1896. Dr. Schneider admits that Reinke's propositions have not generally been accepted as correct, but maintains that they "are based upon sound argument and should, therefore, mark the beginning of the period in which lichens are recognized as a distinct class of plants; such recognition being based upon physiological considerations."

The second chapter is devoted to symbiosis. The subject is divided into antagonistic symbiosis (parasitism), nutricism, and mutualistic symbiosis. Under the latter mutualism and individualism are distinguished, the former characterized by the fact that the symbionts are not wholly dependent upon each other for their existence, while in the latter form at least one of the symbionts is absolutely dependent upon the symbiotic association. The phenomenon of individualism is typically met with in lichens, according to Dr. Schneider, and really forms the basis for Reinke's claim that they should be considered a distinct class of plants. Then follows an interesting discussion of the thallus and apothecium, the structure and function of their different parts, their method of growth, mechanical adaptations, etc.

In the consideration of the reproduction and propagation of lichens, Dr. Schneider contends that the spores are unreliable aids to reproduction, and play only an insignificant part in the maintenance of species, because the spore upon germination may not find the proper symbiont alga and also because in some species the spores are only rarely developed. It is doubtful if his view of the subject will find full acceptance.

The next chapter is devoted to the polyphylogeny of lichens. Five families of fungi are given as probable ancestral groups of fungal symbionts, though the statement is made that it is impossible to study out the ancestral fungal types at present. Nine genera of algæ are given which are known to enter into symbiotic relationship to form lichens.

The system of classification proposed is then discussed. Dr. Schneider begins by the statement that "there is at present no satisfactory natural or artificial system," and then proposes an arrangement into orders, families, genera, and species without further subdivision. One who has worked much with lichens cannot but wonder what he proposes to do with the varieties and subvarieties recognized by all systematic writers on lichens. Will the number of species be indefinitely multiplied or shall we find the description of the species so broad that all the varietal forms may be easily accommodated? Judging from the number of genera recognized the first supposition would be the correct one. The orders recognized are the Ascolichenes, Basidiolichenes and Gasterolichenes, based on the method of spore formation.

As family characters, the probable fungal ancestors, the structure and

development of the apothecium and thallus are suggested, with some reference to the spores and algæ. In view of the earlier statement that it is impossible "to study out the ancestral fungal types at present," the use of those fungal types as a basis of classification must be difficult. As generic characters the spore characters are given as of primary importance; then the development of the thallus, the apothecium, the exciple, the color of the apothecial disk, the algæ, and the color of the thallus. A number of genera are based upon algal differences. As to specific characters our author says "in general it may be stated that in the establishment of species all known characters must be considered more or less." Chemical reaction is considered of no importance in distinguishing species.

One turns with considerable interest to Dr. Schneider's application of his principles of classification, and it is inevitable that one should compare his work with the classic work of Professor Tuckerman in the same line. Thirty-four years elapsed between the publication of Professor Tuckerman's *Synopsis* of the Lichens of New England, the other northern states and British America, and his publication of his *Synopsis of the North American Lichens*. During all that time he was occupied more or less exclusively with the study of lichens, so we may be assured that his *Synopsis* represents his mature judgment. His *Synopsis* covers the whole of North America, Dr. Schneider's *Text-book*, the northeastern United States. We find seventy-five genera in Professor Tuckerman's *Synopsis*, while Dr. Schneider recognizes seventy-seven genera. If we deduct the thirteen genera recognized by Professor Tuckerman of which no species are recorded as occurring in the region covered by Dr. Schneider, and the eleven genera recognized by Professor Tuckerman as occurring in that region but of which Dr. Schneider makes no mention, we can better appreciate how the Tuckerman genera have been divided up.

But what of the twenty-six new genera thus established? Some are recognized by Professor Tuckerman as sections under his genera, some as distinct genera by other lichenologists, but many are established on a very slight basis, as for instance *Mallotium*, of which Dr. Schneider says "the essential character which distinguishes this genus from Leptogium is the presence of numerous long, comparatively rigid, gray rhizoids which extend in clusters from the lower surface of the thallus." When the great variability in the development of rhizoids is considered, one is startled to see them made the basis of a genus. Is this so much more scientific than Professor Tuckerman's work, of which our author says "he also issued a work on genera of lichens and their relationships, which is, however, unsatisfactory, because the author did not seem to have any clear conception of genera."

While recognizing the careful work that Dr. Schneider has done, one cannot but regret that he has complicated still further the study of lichens by the proposal of a new system of classification.—CLARA E. CUMMINGS.

A notable host index.

WHAT DeCandolle's *Prodromus* did for the systematic study of spermatophytes, Saccardo's *Sylloge* has done for the study of fungi. In the eleven heavy volumes of this work all species of fungi described before 1895, over forty-two thousand, have been displayed, with synonyms and geographical distribution. In 1897 an index to genera and species, prepared by Dr. Sydow, was issued, forming volume twelve of the work. And now we have the first part of volume thirteen,[5] compiled by the same bibliographer, indexing the work by hosts. The typographical features of the volume are of the best. The name of the host is printed in bold-faced type, and the names of the attendant fungi are given beneath in a single column. The clearness and the simplicity of the arrangement leave nothing to be desired. With the issuing of this volume the mycologists of the world are placed under a further debt of gratitude to the promoter of the work.— J. C. A.

Fundamental problems of science.[6]

THIS BOOK is an attack upon the theory of so-called scientific materialism, written by a disciple of Schopenhauer. The indictment contains two counts: first, that the theory in question attempts to explain all the phenomena in the world, open to scientific investigation, by means of motion; secondly, that it assumes the reality of matter as an extended impenetrable substance existing independently of our perceptions, and conceives of it as the main, if not the sole, constituent of the universe. In his criticism of the second of these two propositions Dr. Wagner is at one, not merely with practically all students of philosophy, but also with many, perhaps the majority of the scientists of today. Even the drudge, whose ideas never rise above mere label-pasting, has had the problem of the real nature of matter forced upon his attention by the writings of Huxley in England, and Helmholz in Germany — to mention only two of the most eminent. Indeed, it requires but a moderate amount of meditation to discover that one's own consciousness is the sole source of knowledge, and that therefore the only direct information as to the nature of the constituents of the external world is given by sensation. The coming and going of these sensations reveal the existence of certain forces, or perhaps a single force, to whose activity they are due, but until we can jump out of our own skins we can have no idea of the nature of these forces as they are in themselves. Annihilate the conscious subject, and

[5] SACCARDO, P. A.— Sylloge fungorum omnium hucusque cognitorum. Vol. XIII; Index universalis et locupletissimus hospitum fungorum. Auctore P. Sydow. Roy. 8vo. [part I, pp. 1–624.] Berolini: Fratres Borntraeger. 1898.

[6] WAGNER, ADOLF.— Grundprobleme der Naturwissenschaft. Briefe eines unmodernen Naturforschers. 8vo. pp. viii + 255. [No index.] Berlin: Gebrüder Bornträger, 1897. *M* 5.

extension and impenetrability — the qualities of touch — disappear along with color and odor, gone perhaps to look for the hole in the cookie after the cookie has been eaten.

From these premises Dr. Wagner considers himself entitled to conclude that the atom and the ether are pure mythological entities. But here he certainly moves too fast. That the atom does not exist in the sense in which materialism supposes it does may well be conceded, but, though essentially intangible and invisible, the question whether it may not exist in the same sense in which the flower that is "born to blush unseen" may be said to be a reality, is another problem — one to be decided by a study of evidence which lies entirely outside of the province of the metaphysician as such to discuss. As well might he have dogmatized about the formation of crystals from solutions before Leuwenhoek turned his microscope upon them, or about the cause of tuberculosis while Koch was still experimenting with staining fluids.

In our use of the word "cause" we have laid ourselves open to another criticism which our author directs against the atomic theory. The only efficient causes, he tells us, are the forces that lie behind phenomena; and, therefore, to talk of the atom or the ether as active agents in the production of change is an absurdity. In one sense this is true enough, but as a criticism upon the use of these terms by a scientist who knows his business, it is irrelevant. The invisible water in the form of steam, in the cylinder of the engine, is just as truly an agent capable of doing work as is the visible water that turns a mill wheel. Perhaps in all strictness we ought to speak rather of the unknown forces that lie behind the steam, as the true agent; if so we must revise in a corresponding manner our everyday language about the mill stream.

It will be seen that Dr. Wagner's book, clearly and convincingly as it has stated some fundamental truths, is a horrible example of the confusion of the scientific and the metaphysical problems raised by the world of nature. But he is not the first. His immediate predecessor in this line is the illustrious Professor Ostwald, who seems to think he has found in idealism a weapon with which to destroy a theory which he himself has probably rejected on other grounds. And then there are the "scientific materialists." Mistaking the atom for a metaphysical entity they suppose themselves in possession of the clue to the nature of ultimate reality. Reviling all metaphysics, they themselves have swallowed whole one of the shallowest and most dogmatic of metaphysical systems — a spectacle which would certainly be one of the most amusing in the history of thought, if it were not at the same time one of the most mournful.—FRANK CHAPMAN SHARP.

Lessons with plants.

ANOTHER BOOK comes to us from the pen of Professor L. H. Bailey, which is likely to be highly acceptable to the constituency to which it is

addressed. It is not "a botany," as announcements had led us to expect, but, as its title page informs us, a book of "suggestions for seeing and interpreting some of the common forms of vegetation."[7] Those who have seen the teachers' leaflets for nature study, which are being issued under Professor Bailey's direction by Cornell University, have already a fair sample of what this book is in its spirit; indeed, some of these leaflets reappear in the book with only slight adaptation. Perhaps it will not be too much to say that this book is part of Professor Bailey's crusade against the formal dry-as-dust teaching of botany, in which every live teacher wishes him God-speed.

The methods which are suggested to teacher and pupil herein are the proper ones, beyond question; there are no others which can be called teaching. The preface at least we would have every teacher read and ponder; it is rich in pedagogical suggestions, not so new, perhaps, as forceful. The program there laid down is executed in the following pages in most admirable fashion, where, by suggestive questions and hints, the user is led to right interpretations of many familiar objects in the plant world. Accompanying these interpretations are paragraphs in smaller type containing information upon the more formal aspects of the subjects studied; which leads the author into the statement that, as a last resort, "the pupil may recite from the book, for enough of formal statement and definition may have crept into the work to enable it to be used as a simple text-book." But its main purpose is to suggest methods of nature study, "and since the author cannot bring the plants with him he brings good pictures, which are the next best things." These are indeed admirable; fresh, accurate, and rendered with a high degree of artistic feeling. Professor Holdsworth may well be ranked with Sprague and Faxon as a botanical artist of the first quality. Only once, as far as we see in this book, has he failed to interpret in lines what he has seen; figure 321 is quite inaccurate.

It seems almost captious to say anything in unfavorable criticism of a book in which so much is excellent. It is because the methods suggested are so good that we wish there had been more about the neglected lower plants which are quite as common as the flowering ones which the author uses. True, two lessons are devoted to the cryptogams. But will youngsters be any less interested in the green scums, the gray lichens, the matted mosses, the curious puffballs, than in diclinous flowers, to which three lessons are given? Are not these just as common as the commonest seed plant? And would not the formal statement and definition, which might creep in about these, keep things balanced a little better than to encourage the idea that the

[7] BAILEY, L. H.—Lessons with plants; suggestions for seeing and interpreting some of the common forms of vegetation; with delineations from nature by W. S. Holdsworth, assistant professor of drawing in the Agricultural College of Michigan. 12mo. pp. xxxii + 491. *figs. 446.* New York: The Macmillan Co. 1898. $1.10.

flower is the important organ, that seed plants are the *real* plants, and ferns, mosses, and toadstools very much of a side issue?

And then we *do* wish that the pernicious comparison of spores and seeds had not been perpetuated. If Professor Bailey had been condemned for ten years to eradicate from elementary pupils' minds the idea that a seed when it germinates produces a new plant, and to inculcate a true idea of the relation between seed and spore, he would thoroughly appreciate this desire.—C. R. B.

An organography of the higher plants.

A WELCOME BOOK is the recently published treatise on the general organography of plants by Professor Dr. Goebel of Munich.[8] No one who has given attention to the shifting of the point of view of progressive morphologists can fail to observe that the problems in this field are now seen in an entirely new light. No longer is there presented to the student the conception of an ideal leaf or flower, from which, as from a "pattern," those he observes show "deviations" more or less marked, for which no conceivable reason is assigned except the production of "variety in nature." On the contrary, he is set to study the forms of organs as they exist and to seek in external and internal conditions as they influence hereditary "tendencies" (alas, our ignorance!) the efficient causes for the forms he observes. The old idealistic theory of metamorphosis is giving ground to more realistic views of development as we become able to get closer to the plant. It is plain that modern morphology must base itself upon physiology and ecology.

But these exacter views are as yet in their formative stage, and many who are not specialists are scarcely aware of the departure in current literature from the older standpoint. To these, and to the specialist as well, the gathering together of these newer ideas into a compact discussion will be of great service. The present volume is only the first, or general part, to be followed presumably by a second, treating of special morphology, a work which we hope will not be long delayed, spite of the fragmentary character of the available materials. In order to show the nature of the general part we here translate the principal headings:

Section I. The general segmentation of the plant body: morphology and organography, classification of the organs of seed plants, formation of organs and division of labor among lower plants (thallophytes), normal formation of organs at the growing point and regeneration, coalescence (*Verwachsung*) and dwarfing. *Section II.* Symmetry: positions of organs on radial axes, dorsiventral shoots, symmetry of leaves, symmetry of flowers and inflorescences. *Section III.* Differences in the formation of organs at different stages

[8] GOEBEL, K.—Organographie der Pflanzen, insbesondere der Archegoniaten und Samenpflanzen. Erster Teil: Allgemeine Organographie. 8vo. pp. x+232. *figs. 130.* Jena: Gustav Fischer. 1898. *M.* 6.

of development; young forms. *Section IV.* Malformations and their significance for organography: how malformations arise, significance of malformations for the theory of formation of organs. *Section V.* Influence of correlations and external stimuli upon form.

These topics are treated in a clear and concise manner, in German which it is a pleasure to read. If any parts be selected as instructive above others, they would be, in our judgment, the fourth and fifth sections, in which the author discusses the relation of teratology to organography and the formative influence of external stimuli.

In the former, after pointing out the impossibility of an exact definition of abnormalities as distinguished from variations, he shows that monstrosities are not lawless, since the fundament (*Anlage*) of a shoot is never misdeveloped into a leaf or root, nor a sporangial fundament into a vegetative organ. For when stamens or carpels are malformed, it is always the nutritive parts which are developed, while the sporangia are dwarfed. Such structures are not reversionary in the least, but are due to pathological disturbances, and cannot lead to any correct phylogenetic conclusions. Malformations in general, Goebel holds, are either inherited (of which he cites numerous examamples), their development at any particular time, however, being often coupled with the action of external conditions, in whose absence they persist as latent fundaments; or the external factors are the causal impetus of malformations, especially in the lower plants, though examples among seed plants are not wanting. The study of monstrosities leads to the conclusion that Sachs' theory of "Stoff und Form" is the most satisfactory one, *i. e.*, that differences in the forms of organs are due to differences in the plastic materials.

In discussing correlations the author points out two general categories: one, which he calls quantitative correlation, depends on the competition between the fundaments of different organs, which determines the extent of development of the organ; the other, qualitative, influences direction of growth and the form of organs such as thorns, sporophylls, bud scales, and tendrils. In discussing the influence of external stimuli many interesting effects of gravity, light, medium, and mechanical stimuli are cited, of which no outline would convey an idea.

In any attempt to get out of a rut, the very effort is likely to carry one beyond the middle of the road. To this we must ascribe Goebel's objection to the use of the term "leaf fundament" (*Blattanlage*) on the ground that, as the idea "leaf" is a mere abstraction, there can be no such thing as a leaf fundament, but only fundaments of foliage leaves, scale leaves, etc. In support of this general position he argues that if the theory of metamorphosis had started with the examination of roots instead of leaves, it would not have been led into such vagaries, or have generalized the concept "root" until nothing remained but an abstraction. Botanists would have more clearly

recognized that function determines form. But however clearly we recognize now this fact, and however improved become our views of morphology in consequence, it is improbable that categories of homologous organs will cease to demand recognition in our thought and in our terminology.

In a somewhat similar way the author constructs men of straw out of the categories caulome, trichome, etc., and charges them so impetuously that his momentum carries him beyond safe middle ground to untenable positions. So completely has he taken the physiological point of view, that he prefers to base terminology upon analogy, even when he acknowledges that it obscures homologies. This may do for popular speech, but it ought not to continue and cannot long persist in scientific language.

Though every reader may not be able to go the full length with Professor Goebel, it is manifest that he has produced a most useful and stimulating treatise on the organography of plants, which no one who cares to keep abreast of modern views can neglect.—C. R. B.

MINOR NOTICES.

DR. CHARLES F. MILLSPAUGH[9] has published a third contribution to our knowledge of the flora of Yucatan. The Schott herbarium recently obtained, the Witmer Stone collection of 1890 under the auspices of the Academy of Natural Sciences of Philadelphia, the E. P. Johnson collection of 1848 (examined at the herbarium of Columbia University), and the continued collections of Dr. Geo. F. Gaumer, have furnished much material not reported heretofore. Sixteen new species are described.—J. M. C.

TWO USEFUL bibliographical works have recently reached us. One is from the U. S. Department of Agriculture; a library bulletin containing a "Reference list of publications relating to edible and poisonous mushrooms." It has been compiled by Miss Josephine A. Clark, the assistant librarian, to whom botanists are already under obligations for her card index of new species and illustrations. This bulletin seems to have been called out by the of poisoning some prominent persons at Washington lately through eating amanitas. The list contains 306 titles.

The other bibliography is a list of periodicals relating to botany in the New York public library and the library of Columbia University, and also a list of those relating to horticulture and gardening in the same libraries. This 11-page pamphlet reaches us "with the compliments of Lucien M. Underwood," but bears neither imprint nor indication of who its compiler may be. This, however, will not interfere with its usefulness—.C. R. B.

[9] Contribution III to the coastal and plain flora of Yucatan. Field Columbian Museum Publication 25. Botanical Series 1: 345–410. 1898.

THE BOOKLET, *Flowers that never fade*,[10] contains an account of the Ware collection of Blaschka glass models in the Harvard University museum. This description was originally prepared by Mr. F. B. Wiley, the author of the *Harvard Guide Book*, for the Boston *Transcript*, in response to requests for information concerning this unique collection. Revised and considerably extended, it is now reprinted, with a poetic (?) introduction. Fulsome praise mingles with the description of the inception and execution of the work, and of

"The home at Hosterwitz,
Where a lonely artist sits."

The author warmly congratulates Harvard University on being "the fortunate possessor of the only collection of these exquisite creations now in existence," and about them he sings:

"The varying seasons bring
No change to this blossoming:
The spring never ends for these
Enduring anemones;
The summer's reign never closes
For these perennial roses:
The autumn's horn never holds
Even one of these marigolds;
And the winter never comes
To these bright chrysanthemums."

Mum's the word.—C. R. B.

A USEFUL SET of directions for experiments in plant physiology has recently been published by Dr. J. C. Arthur, in pamphlet form.[11] The series includes thirty-five experiments, and are those which he has found serviceable in illustrating a course of lectures extending over five months. The directions are intended only as a guide to manipulation; not to indicate the purpose of the experiment or the deductions from it. The experiments chosen are illustrative of the fundamental processes of plant life, and the pamphlet will be particularly valuable to teachers who are conducting elementary college courses.—C. R. B.

THE INTEREST in native edible mushrooms, and *per contra* native poisonous ones, has been increasing for sometime. Every addition to the literature of the subject is likely to find an expectant public. The recent publication by

[10] WILEY, FRANKLIN BALDWIN.—Flowers that never fade: an account of the Ware collection of Blaschka glass models in the Harvard University museum. 16mo. pp. 41. Boston: Bradlee Whidden. 1897. 35 cents.

[11] ARTHUR, J. C.—Laboratory exercises in vegetable physiology. 8vo. pp. 32. *figs.* 5. Lafayette, Ind.: Kimmel & Herbert. 1897. 35 cents.

Dr. Thomas Taylor[12] of a work on mushrooms, with colored plates of reasonably good quality, will doubtless meet with an appreciative response. Dr. Taylor was for many years the microscopist of the United States Department of Agriculture, and the readers of this journal do not need to be told the character of his work. In this official capacity he issued a number of reports on mushrooms, which have furnished some of the material for the present series.

Although the subject is not treated in a sufficiently systematic way properly to entitle the work to the name of "handbook," and in spite of some irrelevant matter, the mycophagist will yet find much in these pages to help him.— J. C. A.

NOTES FOR STUDENTS.

A NEW Rumex from Colorado has been described by Geo. E. Osterhout.[13] —Further notes on the southern species of Asarum have been published by W. W. Ashe.[14] —Professor E. L. Greene[15] has published another fascicle of "New or noteworthy species," in which the following genera are represented by new species: Delphinium, Myosurus, Viola, Mertensia, Plagiobothrys. Lithospermum, and Eriogonum. In "Studies in Compositæ" some helenioid genera are taken up. The name Actinella, as employed by Nuttall and by Gray, is a homonym, and Rafinesque's Ptilepida (used in the *Check List*) is precluded as a synonym of Persoon's Actinella and not of Nuttall's. Accordingly Professor Greene publishes the name *Tetraneuris*, under which he places eighteen species. Hooker's Picradenia is kept separate from it, and a new genus, *Rydbergia*, is founded on *Actinella grandiflora* T. & G.—Those wishing to keep pace with the synonymy of the species of Asarum should not fail to note the recent brief paper by James Britten and Edward G. Baker, who introduce the new name *A. Shuttleworthii*.[16]—J. M. C.

HERMANN VON SCHRENK'S[17] study of the influence of the tornado of 1896 upon the trees of St. Louis is an important contribution to the general subject of the effect of extraordinary conditions upon plant life. Mr. von Schrenk's

[12] TAYLOR THOMAS.—Student's handbook of mushrooms of America, edible and poisonous. Washington, A. R. Taylor (238 Mass. Ave., N. E.). 8vo. In five numbers of twenty-four pages, and five or six partly colored plates each. 1897–8. 50 cents per number.

[13] Erythea **6**: 13. 1898.

[14] Jour. of the Elisha Mitchell Soc. **14**: 31–36. 1897.

[15] Pittonia **3**: 257–272. 1898.

[16] Jour. Bot. **36**: 96–99. 1898.

[17] The trees of St. Louis as influenced by the tornado of 1896. Trans. St. Louis Acad. Sci. **7**: 25–41. 1897.

observations of the striking phenomena he describes are extensive and valuable. Finding the immense destruction of leaves to have been the most serious damage done by the storm, he points out the disastrous results of the stoppage of the transpiration current and of the manufacture of nutritive products at a time when the uninjured roots were at a period of their greatest absorbing activity. Where the deficiency in leaf exposure was partially made up either by adventitious budding or by premature growth from the leaf axils of the undestroyed twigs of 1896, careful observations were made of the unnatural "growth ring" thus established. This ring, very evident in the surviving twigs, easily traceable in the larger branches of several years formation, was not to be observed in the main trunk. In very many cases, even where the normal functions seemed to have been restored, trees have since died on account of injuries received by the bark, either by violent wrenching or by later intensified insolation. In the latter case, when the temperature between wood and bark must have risen to a height which destroyed the delicate cambium, the bark has since peeled off before the vegetative parts of the tree have shown signs of withering. Such bark-scorching was almost universal, and Mr. von Schrenk predicts that many of the finest trees for this reason will be unable to stand the strain of another summer. Six plates amply illustrate the text.—J. G. COULTER.

F. HEGELMAIER[18] has made an interesting contribution to the subject of polyembryony. In *Allium odorum* he finds embryos developing not only in the normal manner, but also from synergids, antipodals, and from the wall of the inner integument. One embryo sac contained five embryos, one normal, another from a synergid, two from antipodal cells, and still another from the inner integument. Many irregularities were noted both in the suspensor and in the embryo proper. The stock from which the material was taken had been cultivated in gardens for over twenty years.— CHAS. J. CHAMBERLAIN.

A SOMEWHAT MISCELLANEOUS summary of late embryological work is given in the *Rev. Gen. Bot.* of June 1897. The contributions reviewed range from the work of Chauveaud[19] upon polyembryony among the Asclepiadaceæ to Belajeff's well known study of the phenomena of the pollen tube in gymnosperms,[20] and Guignard's *Nouvelles études sur la fécondation*.[21] It is

[18] F. HEGELMAIER.— Zur Kenntniss der Polyembryonie von Allium odorum. Bot Zeit. **55**:.133–140. 1897.

[19] Sur la fécondation dans les cas de polyembryonie. Reproduction chez le Comptevenin. Paris, Soc. d'edit. sci., 1892.

[20] Zur Lehre von dem Pollenschlauche der Gymnospermen. Ber. der de utsch. bot. Gesell. **11**: 196–201. 1893.

[21] Ann. des Sci. Nat. VII. **14**: —. 1891.

too incomplete to be taken for a bibliography of even the most critical of recent contributions in this field, but does offer an easy way of getting at the gist of several valuable but verbose contributions. In the issue of October 15 M. Prunet gives a clear presentation of the embryological investigations of Jaccard [22] on Ephedra and of Karsteñ [23] on Gnetum.—J. G. COULTER.

BY PLACING etiolated leaves, from which the carbohydrate substances have been as completely removed as possible, in contact with various solutions, M. W. Palladine [24] has demonstrated the beneficent influences of certain substances upon the formation of chlorophyll and the retarding effect of others. He lists among substances favorable to chlorophyll formation saccharose, raffinose, glucose, fructose, maltose, glycerin, galactose, lactose, and dextrin. Inuline and tyrosine have no perceptible effect under the conditions employed, while contact with mannite, dulcite, asparagin, urea, alchohol, chloride of ammonia, and quinic acid either checks or absolutely prevents its formation. He also demonstrates by a very simple and efficient experiment that respiration proceeds freely in an atmosphere impoverished of oxygen, in which chlorophyll appears in etiolated leaves not at all or only very slowly.—J. G. COULTER.

RECENT ANNUAL REPORTS from the experiment stations containing botanical information are as follows: The Rhode Island report for 1896 treats of carnation diseases (pp. 203–210) by L. F. Kinney, especially of fairy-ring, rust, and "petrified" buds. The two first mentioned were effectively checked with Bordeaux mixture and removal of diseased leaves; the last is supposed to be due to forcing growth beyond healthful limits, as the buds never open. One-third of the report (pp. 242–318) is devoted to an illustrated account of the extended studies of H. J. Wheeler and G. M. Tucker on the value of lime as a fertilizer for field crops. Beneficial results were obtained with many kinds of plants and at different localities in the state. It is ascribed, after making pot observations, to the corrective action upon soil acidity.

The report of the Vermont station for 1896–7 contains observations upon pollination of the plum (pp. 87–98) by F. A. Waugh, embracing many interesting details; and also some account of the action of enzyms in hastening germination (pp. 106–111), by the same investigator. The botanist of the station, L. R. Jones, writes (pp. 44–74) upon early blight of potato, including a full bibliography of *Alternaria Solani*, upon the effect of disinfectants (cor-

[22] Recherches embryologiques sur l'Ephedra helvetica. Bul. de la Soc. Vaudoise des Sc. nat. **30**: —. 1894.

[23] Beitrag zur Entwickelungsgeschichte einiger Gnetum-Arten. Bot. Zeit. **50**: —. 1892.

[24] Recherches sur la formation de la chlorophylle dans les plantes. Rev. gen. de bot. **9**: 385–394. 1897.

rosive sublimate and formalin) on early growth of potatoes, upon apple scald, oat smut, and onion mildew, and upon the orange hawkweed (*Hieracium aurantiacum* L.), for which salt applied dry at the rate of about 3000 pounds per acre is found to be an effective exterminator. All the topics include many new and important observations.

The report of the botanist of the New Jersey station, Byron D. Halsted, has been distributed as a separate in advance of the full report for the year 1897. It is probably the largest report (pp. 261–394) made by any of the station botanists, and records a great number of observations, mostly relating to plant diseases and fungicides. The turnip, cabbage, potato, pepper, tomato, bean, onion, spinach, egg plant, clover, cucumber, pea, carrot, celery, beet, sweet potato, asparagus, pear, violet, hollyhock, and many other cultivated plants have received attention. Beside pathological studies, experiments were made in shading plants with lath screens, advantageously in case of lettuce, spinach, Swiss chard, celery, and bush beans, and injuriously in other cases. The report is illustrated with thirty-two cuts, all halftones from photographs, and nearly all most wretchedly printed. It seems as unreasonable to print illustrations so badly that nothing can be made out of them as it would be to print the text in a blurred and unreadable condition.—J. C. A.

NEWS.

DR. EDUARD ZACHARIAS has been called to the directorate of the botanical garden at Hamburg.

THE KNIGHT'S CROSS of the Austrian Order of Leopold has been conferred upon Professor Dr. Julius Wiesner.

MR. J. G. LUCHMAN has been appointed Government Botanist of Vicoria, the post so ably filled for many years by the late Baron Ferdinand von Mueller.

PROFESSOR L. H. BAILEY, of Cornell University, sailed for Europe last month. The length of his stay remains uncertain. He is stopping at present in Munich.

FROM *Science* we learn that Messrs. A. & C. Black will publish the lectures given by Dr. D. H. Scott at University College, London, last year, under the title of "Studies in fossil botany."

PROFESSOR ALFRED J. MCCLATCHIE, formerly of the Throop Polytechnic Institute, Pasadena, Cal., has been appointed professor of Agriculture and Horticulture in the University of Arizona, at Phoenix.

DR. RUDOLF A. PHILIPPI, for many years director of the National Museum of Santiago, Chili, has been obliged to retire from the duties of this post by reason of advancing years. He is now in his ninetieth year.

THE CURRENT NUMBERS (169 and 170) of *Die natürlichen Pflanzenfamilien* are devoted to a continuation of the Musci, by Carl Müller, and the Dacryomycetineæ, Exobasidiineæ, and Hymenomycetineæ, by P. Hennings.

DR. D. S. JOHNSON, Instructor at Johns Hopkins University, will have charge of the botany at Cold Spring Harbor during next summer. Work is offered in "cryptogamic botany," "phænogamic botany," and "bacteriology."

PROFESSOR JOHN MACOUN has published in the *Ottawa Naturalist* (11 : 193–204. 1898) the third part of his "Cryptogamic Flora of Ottawa." It contains a continuation of the mosses, which cover some 220 numbers, and also the liverworts, 30 in number.

AN ADDRESS on "The province and problems of plant physiology," by Professor D. T. MacDougal, is published in *Science* (7 : 369–374. 1898). It is a clear and pungent statement concerning a field of work persistently misunderstood, even by teachers of botany.

DR. J. C. ARTHUR'S paper on "The movement of protoplasm in cœnocytic hyphæ," read before the Botanical Society of America at its Toronto meeting, and briefly outlined in this journal (**11**: 181. 1897), has been published in the *Annals of Botany* (**24**: 491–507. 1897).

PURDUE UNIVERSITY is publishing a series of leaflets on Nature Study. The botanical subjects thus far presented are "the foliage leaf," "the flower," "trees," and "a country school garden," by Professor Stanley Coulter. L. H. Bailey's "a children's garden" is also reprinted as one of the leaflets.

MR. JAMES BRITTEN has published (*Jour. Bot.* **36**: 90–94. 1898) an interesting discussion upon the fifty years' limit in nomenclature, proposed in the so-called Berlin rules. There seems to be no question that the rule, even if deemed desirable, would be impossible of application, involving as it does such indefinite requirements as "general use," "monograph," etc.

MR. CLIFTON D. HOWE, of Burlington, Vt., very much desires to know the location of C. C. Frost's collection of liverworts. In connection with Professor L. R. Jones he is making a study of the Vermont Hepaticæ, and expected to be aided by the Frost collection. Not a single specimen has been found in the Frost herbarium, or those of Amherst, Harvard, or Columbia, and no one as yet has been able to give any clue as to the possible whereabouts of Frost's specimens.

A MEMORIAL SHEET has been issued in honor of the late Baron Sir Ferdinand von Mueller. In it we note that the supplemental volume of the *Flora Australiensis*, which was in preparation for the press at the time of his death, is to be published; also two volumes on his administration as Director of the Botanical Garden, comprising a biography and a complete bibliography. The executors are now making an effort to erect over the grave a suitable monument, and are asking subscriptions for this purpose.

AN ANNOUNCEMENT from the Herbarium of the Field Columbian Museum gives the information that during the last two years over 50,000 sheets have been accumulated, well scattered throughout the world, 16,000 of which are from North America. A detailed list indicates the states and collectors chiefly represented. The present arrangement of the herbarium is alphabetical by genera, the American genera in manilla covers, the European in green, the African in blue, the Asiatic in red, and the Oceanican in yellow.

THE NEW ENGLAND BOTANICAL CLUB has published its constitution and a list of officers and members. The officers are George Lincoln Goodale, president; Joseph Richmond Churchill, vice president; Edward Lothrop Rand, corresponding secretary; Emile Francis Williams, recording secretary and treasurer; Walter Deane, phænogamic curator; George Golding

Kennedy, cryptogamic curator. The club meets the first Friday of each month, excepting the summer months; and the herbarium is kept in the Harvard University Museum. The address of the secretary, Mr. Rand, is 740 Exchange Building, Boston.

WITH THE FIRST number of the fourth volume *The Forester* passes into the ownership of the American Forestry Association, which will publish it as the organ of the association. The only information as to its editorial management is the following from the proceedings of the association: "The new journal is to be *The Forester*, being the paper heretofore published by Mr. John Gifford, of Princeton, N. J., which he has conveyed to the association. A newspaper correspondent has been secured as managing editor, assisted by a committee of the association, with Dr. Fernow as chairman." This number (of 24 pages) is devoted to the white pine situation.

THE *Annals of Botany* has published as a sort of preface to Volume XI, completed with the number for December 1897, a biographical sketch and portrait of Professor M. J. Berkeley. The sketch is prepared by Dr. Thiselton-Dyer. Berkeley is said to have been the virtual founder of British mycology, his work in this field having begun in 1836, when he undertook for Sir William Hooker the description of the British species. It is stated that he has probably published descriptions of some 6000 species, with a skill and precision which has made this enormous work durable. In 1846 he began his study of diseases of plants, and is said to have been the first to attack the subject in a systematic manner. In 1857 he published his well-known *Introduction to Cryptogamic Botany*, which was the first comprehensive treatise of this kind in any language.

THE FIRST NUMBER of *Pharmaceutical Archives* has come to our table. It contains a paper on the "Comparative structure of the leaves of *Datura Stramonium*, *Atropa Belladonna*, and *Hyoscyamus niger*," by J. O. Schlotterbeck and A. Van Zwaluwenburg; "Structure of the twigs of *Fraxinus Americana*, by R. H. Denniston, each illustrated by two plates; a continuation of Peckolt's "Folk-names of Brazilian plants and their products," and a continuation of Brown's "Chemical bibliography of morphine 1875–1896" from the *Pharmaceutical Review*. The new journal promises to have in it much material of value to botanists and bespeaks their support. Some details of style and typography have escaped the control of the editor in this number which will be corrected in the next issue. The plates, printed on both sides, are to be reprinted in proper form. The editor is Dr. Edward Kremers, of the University of Wisconsin.